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No. 1

## THE RELATIVE VALUE OF THE SPECIAL SENSES TO THE SURGEON \*

BY WILLIAM J. MAYO, M.D.  
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A WIT recently said, "The specialist is one who knows more and more about less and less." This might be modified to "Most of us know less and less about more and more," which is perhaps truer of the surgeon with regard to the nervous system than with regard to any of the other great divisions of medicine. Although it is undoubtedly true that any attempt by one who is not a specialist to obtain a good working knowledge of the details of the remarkable scientific advances in this field would be futile, it should not be impossible for one to obtain a valuable perspective.

On the wall of the amphitheatre of one of the large English hospitals, facing the students, are five words: "Sight," in large letters; "Touch," in smaller letters; "Hearing," in still smaller letters; "Smell," in fine print, and last, in print so small as to be scarcely distinguishable across the room, "Taste," indicating the estimation of the great surgeon who occupied this amphitheatre for more than thirty years of the relative values of the special senses to the surgeon.

As time goes on I am more and more convinced that the relative values of the special senses to the surgeon as expressed by this master so graphically are approximately correct. If one were to estimate from the accuracy rather than the value of perception, perhaps the sense of smell would come first, because man is able to recognize through the sense of smell odors so delicate that there are no instruments of sufficient precision to give cognizance of them. Vapors and gases represent colloid and molecular combinations, but these subdivisions of matter lie in the ultramicroscopic field beyond direct vision.

Again if one takes as a guide the primitive character of the senses, touch would come first because it is related to the earliest form of sensation, namely, stimuli which affect the coverings of the body, as in the subvertebrate, the amphioxus.

To animals that moved about to obtain food, some form of consciousness became essential.

Receptors, the earliest form of nervous system, are apparatus that receive

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\* Read by title before the American Surgical Association, May 14, 1927.

impressions from surroundings and activate other structures. Sherrington has defined a receptor as the peripheral apparatus which receives a stimulation.

Man's distance receptors consist of the organs of the five special senses of touch, taste, smell, hearing, and sight. All these senses have their origin, from the standpoint of embryology and comparative anatomy, in the sensations originally derived from the external envelopes which protect the organism. As the animal organisms became more complex, receptors were more or less connected with the cerebrum, the sense organ of intellectual life which had its origin in the olfactory ganglion of the invertebrates. The neopallium, that part of the brain which did not originate in the olfactory ganglion, gives a fuller representation of all the senses and carries on the conscious as well as the unconscious activities in the control of the mechanism of life.

In the lower animals (non-primates) the sense of smell controls behavior because it is the only sense directly connected with the expanded olfactory ganglion which represents the cerebrum in the lower vertebrates. The other senses are relayed, so to speak, through various centres and may be garbled in transmission.

In the primates, for instance man, the cerebral cortex, which is the seat of intellectual functions, underwent huge expansion. This expansion came coincidentally with the development of vision, dwarfing the olfactory origin. Vision thus secured direct access to the cerebral cortex, while smell retains direct connection with the cerebrum, and is marvelously sensitive; it has small function as compared with vision.

The gray matter of the cerebral convolutions records and classifies impressions, analyzes experience, and activates emotions. Intellectual functions cannot be ascribed entirely to the special senses, but are rather the sum total of both external and internal sensory impressions interwoven into a complex mechanism controlling behavior.

The sense of touch is a pressure sense. In common parlance, touch in man refers to the hands, which the upright position of the human body has freed for highly specialized training.

The sense of taste and the sense of smell are chemical senses and are closely allied. The sense of taste depends on nerve endings largely in and about the tongue and is perhaps the least important and the least delicate of any of the special senses, recognizing only four types of food or modifications thereof: sweet, sour, bitter, and salty. The qualities ordinarily known as flavors are not dependent on the sense of taste, but on the sense of smell which is extraordinarily delicate, recognizing ultramicroscopic substances suspended in the air as vapors and gases. The sense of taste alone could not distinguish an onion from an apple.

Perhaps the reason for failure of the sense of taste to measure up to that of many of the lower animals is that the mobile tongue of the lower vertebrates is used not only to bring food into the mouth and to aid in mastication, but also to determine the edibility of various materials. The tongue of man is not a descendant of the tongue of the lower vertebrates, but on the contrary



is a relatively new development for other purposes, such as speech, as well as sensation.

The olfactory cells on which the sense of smell depends are arranged in bundles and each cell has a hair ending. The function of these hair endings may be to recognize the impact of molecular colloid substances in gases and vapors (either from size or rapidity of motion) as odors, just as differences in the speed and length of rays of refracted light are recognized by the eye as colors in the lines of the spectrum.

The sense of smell in man is represented by only about one square inch of pigmented olfactory nerve cells, a very small amount as compared with the olfactory organ in many of the lower animals. In the hound, for example, this sense is exceedingly accurate while the sense of sight is defective. The approximate location of the quarry is determined by its odor, but the exact location is visual, because the sense of smell does not possess the faculty of recognizing time, space, or motion. The deer recognizes its enemy by the characteristic odor carried by air currents an almost incredible distance. It is interesting to note that the new-born fawn has no odor during the early days of its life, and thus is protected against its enemies in the days of its helplessness. The pigmented cells are necessary to convey odors to consciousness. Albinos have no pigmented cells and therefore have no sense of smell. Sheep-raisers send the albino lambs to the butcher because it is known that they cannot distinguish between noxious weeds and proper food and sooner or later would die from poison.

The sense of hearing is to a certain extent a pressure sense. Among the lower vertebrates, fish have a so-called sixth sense situated in the lateral line labyrinth organ of Leydig which enables them to appreciate pressure, depth, and equilibrium. The ear of land animals responds to sound waves and pressure changes in the air as that of the water vertebrate does in water. This sensitiveness to change in air pressure will be noted on the descent from mountains to a lower region, and in the length of time a sound requires to reach the ear. The relation of equilibrium to the fluid contained in the semi-circular canals is an evolution from a water vertebrate to a land vertebrate. A cat dropping from a height lands on its feet and in the process of righting the body during the fall the head turns first, due to the speed of the reflex mechanism of the labyrinth adjustment.

It is interesting that the organ of Corti in the ear contains certain fine hairs about which little seems to be known, although Helmholtz sixty years ago suggested that the varying lengths of these hairs might have to do with the recognition of tones. Our knowledge of the radio, little as it is, suggests that the possible function of these hairs on the organ of Corti is to receive vibrations in the air and to distinguish certain wave lengths as pitches of sound. The sense of hearing in certain of the lower animals is more acute than in man. The cat recognizes tones of higher pitch than can be recognized by man. The bat hears the wing tones of insects pitched in a key beyond recognition by the ears of man.

In one respect the sense of hearing and the sense of smell are unlike. The sense of hearing as a rule diminishes with age, whereas the sense of smell often grows keener; it is usually more delicate in women than in men.

Picturesquely speaking, 95 per cent. of man's information is obtained either directly by visual means or indirectly through visual training of the other special senses. The direct connection of the eyes with the cerebral cortex controls behavior in man and not the superior mechanics of the eye, which in many respects is inferior to that of the lower animals. For instance, if man had the telescopic vision of the eagle, he could read ordinary print at 500 feet. In many of the lower vertebrates each eye sees independently and in only two diameters, length and breadth, whereas in man binocular vision gives sight in three diameters, length, breadth, and depth. The snake has no macula lutea and sees only objects in motion.

Certain fish in the depths of the sea radiate cold light, not necessarily connected with the eye, but emanating from specialized cells in various parts of the body, differing according to the habits and necessities of fish life, which permits a certain amount of vision. Cold light is also seen in the glowworm, the fire-fly, and other animal organisms. Much research is being carried on to determine the nature of this light, in the hope that it may be used instead of the hot light obtained by present-day oxidation methods.

The introduction of the microscope by the Jannsens in 1590 revolutionized medicine. This discovery came too late to benefit Harvey (1578-1657) greatly, but it gave the hand lens to Hunter (1728-1793) and the modern microscope to Lister (1827-1912) and Pasteur (1822-1895).

We now face through ultramicroscopic methods a new advance in medicine by means of physics and chemistry of almost equal importance to the invention of the microscope. With the X-ray the atom has been analyzed. Belchier of Guy's Hospital, London, introduced the dye, madder, in 1764, for the injection of blood- and lymph-vessels to aid anatomical dissection. Through modern colorimetry methods have been perfected for making various laboratory tests of the greatest value. The phenolsulphonephthalein test of Rowntree and Geraghty for urea filtration through the kidney has been possible, since the molecule of phenolsulphonephthalein is the size of that of urea and is eliminated as that of urea is eliminated. The phenoltetrachlorophthalein test for hepatic function is the best known if jaundice is not present.

Photography has been so developed that in  $1/12,000,000$  of a second a bullet in flight with a muzzle velocity of 3000 feet a second can be photographed as though standing still. Through such photography the eye can make its investigations at leisure.

The value of vision lies not alone in sight, but in education of other senses as well, as exemplified in Helen Keller, Ole Bull, and a host of others born without certain special senses but with wonderful intelligence when trained by the eyes of the educator.

The relative value of the sense of taste is the least important. It should not be neglected, however, for it was through the sense of taste that sugar in

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the urine of the patient with diabetes was first detected and its significance determined.

The sense of smell, in spite of its extraordinary accuracy and delicacy, is but a degree more important to the surgeon than the sense of taste. Nevertheless, every student should be trained to use the sense of smell. The older practitioners were often adept in this now neglected field. It requires but little training for the surgeon in passing along a corridor in a hospital to distinguish between the odor from a fistula in the sigmoid and that from a fistula in the cæcum, ileum, or jejunum. At times the odor of the breath of a poisoned patient gives a clue to the nature of the chemical poisoning.

As between the sense of hearing and the sense of touch, arguments can be brought up from both sides. The discovery of the stethoscope, and the use of percussion and auscultation marked a great advance in medicine, but we all know the inaccuracy of those methods and how little reliance could be placed on them until the X-ray and surgical operation enabled us to make correction of the fallacies.

The old adage that the hand is quicker than the eye is true, but the hand in question was that of a prestidigitator, and was trained by the eye.

If there is a sixth sense, it is intuition, that instinctive summing up of memories and other evidences collected by the special senses and correlated in man's consciousness.

There is a growing tendency in the medical profession to depend more and more on mechanical aids and laboratory tests, with neglect of those fundamental senses on which we are entirely dependent for all our knowledge of the outside world. This should not be.

# ABDOMINAL SURGERY IN THE PRESENCE OF INFECTION CAUSED BY THE STREPTOCOCCUS HÆMOLYTICUS\*

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It is occasionally possible and legitimate to enunciate broad principles of treatment by the study of a single case. The results obtained in an individual instance may illustrate in a striking fashion the value of employing certain methods of treatment which are based on sound theory or on experimental investigation and clinical experience. With this object in view I venture to record a case of infection by the streptococcus hæmolyticus originating in a tuberculous Fallopian tube and implicating the peritoneum and the superficial wound in the abdominal parieties. An attempt will be made to assess the value of certain factors which contributed in securing a successful issue in this case of virulent infection, complicating an abdominal operation, after a long and tedious illness. The case is as follows:

O. E., aet. seventeen, had complained of pain in the right iliac region twenty-four hours before operation. During the week previously she had some small boils on the back which were incised; these had healed. She felt nauseated but did not vomit and she had passed a disturbed night. When seen by the writer three hours before laparotomy she had a temperature of 103° F., pulse 130, and a patchy dry and furred tongue. The respirations were chiefly thoracic with a considerable degree of splinting of the abdominal wall. Palpation elicited exquisite tenderness in the right iliac region; palpation on the left side low down produced pain in the right side. There was slight comparative rigidity of the right lower quadrant of the abdomen. The leucocyte count was 23,500. A diagnosis of acute appendicitis was made and immediate operation advised.

The abdomen was opened through the outer border of the right rectus muscle. The appendix, which was swollen and congested, lay deep in the pelvis and was there adherent to a greatly distended right Fallopian tube. The tube was twisted acutely backwards and was firmly adherent at the bottom of the pouch of Douglas. The peritoneum about the appendix and tube was markedly congested. The appendix was first mobilized and removed. The tube was also freed and about a drachm of material resembling pus escaped, but it did not noticeably diminish the size of the tube. The right tube and ovary were removed. The abdomen was closed without drainage. The operation throughout was carried on with the least possible amount of traumatism, special care being taken to prevent damage to the peritoneal surfaces both visceral and parietal. The only structures handled or bruised were those which were removed, viz., the appendix, the tube and the ovary.

Laboratory investigations showed that the Fallopian tube contained pus: a direct smear showed many pus cells and Gram-positive cocci in chains. Culture showed Gram-positive cocci in short chains and in small scaly colonies, streptococcus hæmolyticus. Histological examination showed tubercle in the tube in which the bacillus tuberculosis was stained successfully in the tissues, where also streptococci were found in large numbers. The appendix showed an acute inflammatory condition with polymorphonuclear infiltration.

*Post-operative History.*—On admission to the hospital her pulse was 150 per minute

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## ABDOMINAL SURGERY IN PRESENCE OF INFECTION

and her temperature  $103.4^{\circ}$  F. After operation the temperature came down very gradually until on the ninth day it was  $99^{\circ}$  F. The pulse, however, remained at 110–120 per minute. The stitches were removed on the ninth day and a few hours subsequently the temperature again rose to  $102^{\circ}$  F. These nine days were marked by an undue amount of restlessness. On the tenth day a scanty discharge of sero-pus escaped from the wound. During the next few days the temperature varied from 99 to  $102^{\circ}$  F. At no time did she exhibit any symptoms of peritonitis, the bowels moved freely, the abdomen remained flat, and she took nourishment well.

On the fourteenth day the temperature rose to  $103.6^{\circ}$  F. From the wound was obtained a pure culture of streptococcus hæmolyticus. The blood culture was sterile, the leucocyte count 15,600. At this juncture, Doctor Maitland gave her  $\frac{1}{4}$  c.c. of 1 in 200 phenol solution intravenously. And this was repeated every second day until seven such treatments were given. Some definite results were obtained. A smear taken from the wound before and after the intravenous administration of phenol showed that markedly increased phagocytic action resulted. The opsonic index was greatly increased by the phenol. In addition there was a gradual recession and then a sudden rise in both pulse and temperature with increased, free discharge from the wound.

On the twenty-sixth day after operation and after the fourth injection of phenol, the superficial wound was opened up, under gas anæsthesia, for the purpose of securing better drainage. The infection was found to be quite superficial: the aponeurosis was intact. The superficial fat and fascia presented a nasty grayish ground-glass appearance with dirty pulpy material here and there. Pelvic examination showed everything normal in that situation. Two large drainage tubes were secured in this superficial wound. The phenol injections were continued at varying intervals until, in all, eleven treatments were given. The last injection being given on the forty-third day after operation.

After several remissions of high temperature and pulse she gradually improved and, six weeks after the operation, the wound had largely closed. She still had an occasional rise in temperature to  $100^{\circ}$  F., but her general condition had improved vastly. She subsequently went to her home with a discharging sinus, this remained open for some months. Her doctor pronounced her well seven months after operation. For the past four years, since the operation, she has enjoyed perfect health.

Mixed infection in tuberculous lesions is very common. In this case, however, while it was obvious that an acute infective process of a virulent type existed, one was not able to determine its true nature until bacteriological investigations were carried out. The operative treatment in such cases demands careful technic and sound judgment. We propose to discuss certain features of the technic which may be employed.

*Trauma.*—The uninjured peritoneum possesses a high degree of resistance to infection. A principle of treatment, therefore, which is essential to observe in all abdominal operations, is to prevent injury to that delicate endothelial surface. It is possible to carry out extensive manipulations, within the abdomen, without causing damage to the peritoneum other than that of the serous surface of the organs which we remove. Thus an adherent appendix may be removed without damage to the surrounding structures. It may be necessary to handle the appendix itself roughly in our manipulations but, with care, any bruising and the damage done by pressure and friction may be confined to the appendix, so that after the appendix is removed a normal, uninjured peritoneum is left behind. The same principles should be observed in per-

forming a hysterectomy or in resection of the intestine for malignant growth, etc. It may seem a very elementary point, but the observance of it is essential for successful abdominal work. Incidentally it is an argument for extensive parietal incisions so that adequate inspection may be made of the field of operation. A good illustration is afforded in intestinal obstruction of unknown origin. Here an extensive incision should be made, the distended gut should be allowed to escape freely into soft towels soaked in normal saline solution, the seat of obstruction is sought with the greatest gentleness and the cause removed with the minimum amount of damage to the peritoneum.

This principle of minimizing the damage to the peritoneum was carefully observed in the case under consideration.

*Drainage.*—One has heard the dictum stated “when in doubt drain.” It is, in our opinion, a most dangerous and fallacious doctrine. To put it strongly one may assert that to have introduced a drainage tube, in the case just cited, would have killed the patient! An adverse criticism of the use of the drainage tube many years ago was to the effect that “the drainage tube is often the cause of the infected matter which flowed through it.” While this may be true, we all know it is essential to drain a septic focus in the peritoneum when we know that suppuration will continue and that general peritonitis is likely to occur if we close the abdomen without drainage. Clinical experience teaches us that fact. On the other hand, it may be possible, it *was* possible in the case under consideration, to remove the septic focus and leave undamaged peritoneal surfaces behind.

In our opinion it requires most careful judgment to determine when to drain and when to close without drainage. We cannot be dogmatic on the question of drainage. The point one wishes to insist upon is that while it may be absolutely necessary to drain in many instances, it is equally essential to desist from drainage in others. The very presence of the drainage tube, in causing damage to the delicate peritoneum, may result in a spread of the infection, thus resulting in the very disastrous extension of the trouble which we seek to avoid.

We often have occasion to observe that the peritoneum possesses a higher degree of resistance than the superficial tissues of the abdominal wall. In that respect our case affords a good illustration. It frequently happens in the case of the removal of an acutely infected appendix, when the abdomen is closed without drainage, that the patient recovers without peritonitis but the superficial fat and fascia become the seat of infection and suppuration. The presence of a drainage tube in the abdomen would, in such cases, be a distinct menace. In the case cited a drainage tube in the abdomen would almost certainly have resulted in an invasion of the peritoneum by the streptococcus hæmolyticus.

*Phenol.*—The value of intravenous administration of phenol is worth consideration. Dr. H. B. Maitland, formerly one of my colleagues in the

## ABDOMINAL SURGERY IN PRESENCE OF INFECTION

University of Toronto, was good enough to carry out the intravenous administration of phenol as recited in the clinical history. Doctor Maitland is now on the staff of the Lister Institute in London and he has sent me the following personal note on the use of phenol in this case: He states as follows:

"Phenol was given to this patient to obtain a non-specific increase in the bactericidal value of the blood. In the sense that all the details of the mechanisms of such increase have not been worked out, the employment of phenol may be regarded as empirical, but on the other hand, some experimental results have been obtained which warrant its use on the basis of well-known principles. It can be shown experimentally that certain small concentrations of phenol added to defibrinated blood will, after a short incubation at 37° C., increase the phagocytic value of the blood. It is thought that phenol acts on the leucocytes. The effective degree of concentration varies somewhat from one person to the next, and should be determined for each case. The dose for an adult has usually been from  $\frac{1}{4}$  to  $\frac{1}{2}$  c.c. of 1 in 200 phenol intravenously. The increase in phagocytic value comes on in from one-half to one hour and is probably of short duration (less than twenty-four hours). Daily administration therefore may be advisable, although some evidence has been obtained that stimulation could be carried too far if daily injections were continued over too long periods."

"In two cases where pus had collected, and to which phenol had been given, films from the discharge showed a marked increase in phagocytosis after phenol had been administered. Observations on the influence of phenol in phagocytosis in discharges from wounds have not been numerous, but these two cases suggest that the response to phenol may not be limited to the blood."

Doctor Maitland explains that the technic he employed in testing the efficacy of phenol in this case was to add various concentrations of phenol to defibrinated blood (saline as a control), incubate at 37°–50 minutes, and make opsonic determinations with each sample of blood plus phenol—using staphylococcus in the ordinary way as a test organism for opsonic activity.

Defibrinated blood from the case here reported was mixed with the following concentrations of phenol and incubated at 37° C. for 50 minutes. It was then tested for phagocytic value with staphylococcus. The following results were obtained:

	Staphylococci ingested per 100 polymorphs	Phagocytic Index
Blood plus saline .....	787	
Blood plus phenol 1/500,000 .....	839	1.06
Blood plus phenol 1/1,000,000 .....	733	.93
Blood plus phenol 1/2,000,000 .....	832	1.05
Blood plus phenol 1/4,000,000 .....	926	1.18
Blood plus phenol 1/8,000,000 .....	894	1.13

The optimum concentration was 1/4,000,000—and judging the volume of blood by the patient's weight, one calculated the amount of 0.5 per cent. phenol in saline, it was necessary to give to obtain this concentration.

*Summary.*—This short paper emphasizes the importance of observing certain principles of treatment which must be observed in our operative technic in abdominal surgery. The avoidance of unnecessary trauma and the exercise of sound judgment in determining the indications for drainage; more particularly does one stress the extreme danger of employing drainage in certain cases and in condemning the theory that the introduction of a drainage tube into the peritoneal cavity is always a safe procedure and that it should be employed whenever one is in doubt. A study of the case cited illustrates the value of the intravenous administration of phenol as a means of increasing the resistance of the individual to infection, particularly when due to the streptococcus hæmolyticus. Evidence is produced to suggest that phenol thus employed increases the phagocytic activity of the blood and probably of the tissues.



## SECONDARY OPERATIONS ON THE ABDOMEN\*

BY JOHN B. DEEVER, M.D.

OF PHILADELPHIA, PA.

THE surgeon at the operating table naturally approaches his case with a certain degree of confidence in his ability to correct the presenting pathology. Indeed, it is true that ordinarily, with a thorough understanding of the lesion, together with proper and careful technic, he has the satisfaction of seeing a prompt recovery and of dismissing a satisfied patient. It is the exception that calls forth this paper.

A certain proportion of abdominal surgery, as we all know, is devoted to secondary operations, demanded within a few hours or at a more or less remote period after the first intervention. Some of these operations are unavoidable and the probability of re-operation is known to the surgeon at the primary one, although it is not within his power to prevent it. But there is another group of cases, in which it is more or less difficult to account for a recurrence of symptoms, especially when a mental review of the case in question gives every reason to suppose that the lesion had been efficiently disposed of. Nevertheless, it is not unusual for patients, after a post-operative period of months or years of perfect well-being, to return to the hospital with symptoms suggestive of some trouble related to the first operation. It has occurred to me that a review of our secondary operations might throw some light on the causes that lead to the same, and that a clearer understanding of them may be of value in reducing their number. It is gratifying to me to note that the records of the ably-conducted Follow-up Service at the Lankenau Hospital have materially lightened the work in connection with this study.

We find that the majority of secondary operations are required for the sequelæ of appendicitis, cholangitis, cholecystitis, choledochitis, peptic ulcer, hernia, etc. The responsibility for these sequelæ, I am glad to say, is a divided one, for in many instances the first operation was performed elsewhere; and furthermore, we are able to note that most of the returned patients had presented more or less advanced pathology at the primary operation.

Dividing these secondary operations into an early, a later, and a remote group, it becomes apparent that re-operation comparatively soon after the primary operation in the first two groups is usually demanded because of hemorrhage, secondary collection, obstruction and fistula; and in the remote group, for intestinal obstruction, vicious circle, marginal ulcer, and in rare instances for the removal of a foreign body such as a sponge, instrument, or needle overlooked when closing the abdomen.

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\* Read before the American Surgical Association, May 13, 1927.

In the later groups the second intervention is most frequently required for adhesions, persistence or return of symptoms of disorders of the biliary or of the gastro-intestinal tract. In the biliary tract, the cause may be inflammation of, or stone in the common or the hepatic duct, inaccessible at the primary operation and later working its way into the common bile duct; or to a chronic cholangitis, or a chronic pancreatitis, developing later as a result of the advanced pathology found at operation, or to adhesions or fistula. In the gastro-intestinal tract the reason for the return of symptoms is very likely due to the omission of a gastro-enterostomy at the original operation, that is, mere excision of a chronic ulcer or mere closure of an acute perforated ulcer.

The remote lesions occurring from several months to several years after the primary operation are chronic, subacute or acute obstruction, due to adhesions; incisional hernia, or recurrent inguinal hernia; marginal ulcer, malignancy, persistent and obstructive pylorospasm after closure of acute perforated ulcer without a gastro-enterostomy. Advanced biliary tract disease, large peptic ulcers with much peri-ulcerous exudate, and diffuse suppurative conditions are especially pernicious since they may lead to pathology requiring repeated operative intervention. This is particularly true of chronic and acute cholangitis, and chronic or subacute pancreatitis in which drainage was not established, or if established was not kept up long enough. Unless each later operation in these cases consists of prolonged drainage, relief may be only temporary and recurrence of the same symptoms in an aggravated form will follow.

*Adhesions.*—The peritoneum rapidly acquires an astonishing degree of immunity and to a degree becomes insensitive after multiple operations. In our experience, adhesions seem to be more apt to develop in some patients than in others, that is, there seems to be a predisposition to form fibrous bands and pathological peritoneal sheets. On the other hand, cases are occasionally met with when there is every evidence of the presence of an appendiceal abscess with plastic exudate, but the patient refuses operation at the time, and when coming to operation sooner or later, may show absolutely no evidence of previous inflammation. It is true that adhesions form as a part of the battle against infectious processes, and are thus a defensive and purely constructive means of protection used by nature to stop the bacterial invasion. Unfortunately too often they not only limit the infection, but at the same time create a mechanical obstruction. Generally speaking, the formation of adhesions depends on the resistance of the patient and of the peritoneum, as well as on the type and virulence of the micro-organism present, the location of the primary affection, the ability of the surgeon to eradicate and to avoid the spread of infection, and the control of hemorrhage, as well as the proper technic, such as the protection of raw surfaces, avoiding trauma, and the kind and amount of drainage material used.

The damage in such cases is due to chronic induration of the delicate submucosal and subseral tissue, whether it be gastro-intestinal, biliary, or intes-

tinal involvement, together with mechanical interference due to contracting or constricting fibrous tissue in the form of membranes, bands or scars. Such a situation may result from a primary local inflammatory process permitted to become diffuse, in which event, even the master surgeon may be compelled to sacrifice local results in order to conserve life, or it may occur from defective technic or haste on the operator's part, thereby changing a benign and simple condition into a malignant and complicated one. The best way to limit the formation of adhesions is to limit the infection within the abdomen.

*Intestinal Obstruction.*—Acute appendicitis is one of the most common surgical affections of the abdomen, and the operation is always a major surgical procedure. It is also the most frequent etiologic factor in intestinal obstruction. This may occur immediately after operation or may not develop until several months or even years later. In the Lankenau Clinic thirty-one (56 per cent.) of the last fifty-four cases of intestinal obstruction followed operation for appendicitis, the pathology in each instance being a suppurating ruptured or gangrenous appendix with local or spreading peritonitis. Appendicitis also heads the list of the primary causes of secondary operations and owes this prominence to the still prevalent practice of ignoring or misinterpreting cardinal symptoms and delaying action. This accounts for the frequent incidence of secondary collections, subdiaphragmatic abscess, obstructive adhesions, and fistula. For as we all know, all of these may occur in one and the same patient.

Sometimes intestinal obstruction occurs within three or four days after the evacuation of an appendiceal abscess, especially where the terminal ileum had formed a part of the abscess wall. This happens when the appendix lies beneath the terminal ileum and mesentery, and points downward and to the left. I have also seen this occur after the removal of a very long chronically diseased appendix holding the latter position where the appendectomy left a raw surface. In the acute cases the walls of the terminal ileum are found more or less infiltrated and stiff, favoring sagging of the proximal bowel which then becomes adherent either to the wall or to the margin of the wall of the abscess cavity. Where the cavity has been coffer-dammed this is not so likely to occur as where drainage (cigarette or rubber tube drains) has been used. In coffer-damming, the bowel is supported and by allowing the coffer-dam to remain several days the infiltrated bowel wall has a better chance to recover its integrity. Nevertheless obstruction at a much later time may occur. If under the above circumstances I feel any uncertainty at the first operation, I anastomose the ileum proximal to the infiltrated area to the colon. The only regrets I have in this connection are those of omission. One or more entero-enterostomies is good surgery in certain inflammatory conditions with partial or complete obstruction of the small intestine.

*Fecal Fistula.*—A third possible and very unpleasant sequel of acute appendicitis is fecal fistula. Our records show that in 4620 operations for appendicitis, fecal fistula followed in 222 patients, or an incidence of 4.7

per cent. Of these, 39 per cent. healed spontaneously, 49 per cent. required a secondary operation, and 13.5 per cent. refused operation. The duration of fecal drainage varied from twelve hours, after which spontaneous closure occurred, to nine years of intermittent drainage. Before resorting to re-operation, in the early cases, we wait several days and occasionally several weeks or even months, to see whether spontaneous closure will not take place. Fistulæ of the upper gastro-intestinal tract are more devastating than those lower down. They occur in cases where an extensive operation with considerable drainage has been performed, and a frequent cause again is the appendix with a perforation close to the cæcum. In late cases of suppurative appendicitis pus is often found beneath the diaphragm, the liver, lateral to the ascending colon (external para-colic groove), around the cæcum and terminal ileum, and in the pelvis with occasional foci between the neighboring coils of ileum. These pus collections cause a pressure necrosis resulting in fistula of the large as well as the small bowel. Surgical experience has led me to apply thorough drainage to all these cases and to leave the wound open. But I am not surprised if a fistula develops. A fistula may also result if the drainage is too compact or left in too long. The site of the fistula will of course depend on the location of the damaged tissues. Drainage from a fistula of the large bowel as a rule does not irritate the skin, but that from an opening in the small bowel usually causes considerable irritation and burning. The higher the opening in the small bowel, the more severe the irritation of the skin about the wound.

The operative repair of a fecal fistula consists in inversion of the opening in the intestinal wall by a re-inforced purse-string suture. If extensive destruction of the bowel is present, an ileocolostomy and, in certain cases, resection may have to be done. In the event of recurrence, further resection may be required. It is true that incisional hernia may and usually does occur in these cases when free drainage has been used and only a few retaining sutures hold the wound together. But the gravity of the situation demands heroic measures and free drainage is essential.

The biliary tract offers another fruitful source for secondary intervention. In a series of two thousand seven hundred operations for disease of the biliary tract in the Lankenau Clinic, one hundred and forty-three (5.3 per cent.) were re-operated cases. In a small percentage of these cases the symptoms persisted immediately after the first operation, others were free for several weeks or months, while many were relieved of all symptoms for one or more years, after which time symptoms referable to the biliary tract again appeared. The phenomenon may be due either to preëxisting pathology, present at the time of the first operation, such as a small stone in the hepatic or common duct, or in the later cases it may develop as the consequence of cholelithiasis, cholangitis, chronic pancreatitis, adhesions, or stricture of the common duct.

Since the principle of removal of a diseased gall-bladder when possible,

has been substituted for drainage of the gall-bladder, the number of cases requiring secondary intervention has diminished twenty-five per cent.

How can we explain this persistence of symptoms after the gall-bladder which showed definite lesions has been removed? One cause may be visceroptosis. We therefore make it a practice to rule out ptosis by the X-ray before the first operation, and if present, correct it by posture and support after the operation. In overlooking visceroptosis repeated operations may be resorted to without improvement and the patient's condition may become steadily more distressing.

*Adhesions.*—After surgery of the gall-bladder and the biliary tract, adhesions to the hepatic and common ducts, the liver, the duodenum, or the hepatic flexure, are found in more than fifty per cent. of secondary operations. They form as the result of infection, trauma, hemorrhage, congestion and stasis, and unprotected raw peritoneal surfaces. Nowhere in the abdomen should the surgeon handle the tissues more “lovingly” as Crile puts it, than in the right upper quadrant. I have frequently been confronted with such a mass of adhesions that it was all but impossible to find the usual landmarks. The stomach and duodenum may be so matted together with the hepatic flexure of the colon and the great omentum and the whole so fused to the under-surface of the liver that, only with the utmost patience and determination can the situation be solved and the common duct exposed to view. In certain of these cases I make a gastro-enterostomy in the hope of avoiding obstruction in the future. Stricture of the common duct may be due to extraductal adhesions, or to intraductal scar formation due to the presence or the passage of a stone. Occasionally spasticity of the musculature of the biliary tract and the duodenum, part of a neurasthenic constitution touched off by disease of the biliary tract, may give rise to a situation difficult to correct by any measures known to the surgeon.

In my opinion infection of the gall-bladder also indicates a certain degree of infection in the liver, and very frequently the main ducts are included in the picture. Removal of the gall-bladder may eliminate enough of the pathology to enable the cellular and hæmatogenous regenerative forces of the body to overcome the smouldering process in the liver and its main channels. Since chronic biliary tract disease may give rise to a low-grade catarrhal gastritis with subacidity or anacidity, and since removal of a diseased gall-bladder does not always influence the condition in the stomach, and as we all know, a low acidity favors bacterial growth, it is possible that this is another cause of re-infection.

Secondary operations may be required for chronic pancreatitis, especially when the head of the pancreas is enlarged and sclerotic, due to a descending infection from the biliary tract by way of the lymph channels. Stasis of bile in the common duct increases stasis in the pancreatic duct, and stasis of the pancreatic secretion in turn plays a rôle in the development of pancreatitis. Observations in our Follow-up Clinic show that patients suffering

from cholecystitis with an associated hardness of the head of the pancreas at the time of operation, do not recover health so promptly as those in which cholecystic disease alone was found. Pain seems to persist and the stools show an increase in the neutral fat and fatty acids as well as undigested protein fibres. Diastase is present in the urine and lipase in the blood serum. Thus we have another important cause of persistence of symptoms following operation for gall-bladder disease calling for secondary operation. Where there is cicatricial or spasmodic contraction of the papilla of Vater the condition is intensified, and the procedure at re-operation consists of dilatation of the papilla and drainage of the common duct by means of a T-tube. If the gall-bladder has not previously been removed, a cholecystoduodenostomy may be done, although I believe external drainage is the better procedure.

Occasionally fistula develops after operation on the biliary tract. After cholecystectomy this may be due to an overlooked stone in the common duct and slipping or premature absorption of the ligature on the cystic duct. After cholecystostomy it may be the result of a stone in the common duct or of calculous or inflammatory obstruction of the cystic duct. Injury to the common duct or the duodenum also may cause a biliary fistula. In a certain percentage of biliary fistulæ, drainage from the duodenum into the fistulous tract may occur. These are serious and difficult to treat as the powerful digestive enzymes rapidly affect the surrounding tissues.

*Peptic Ulcer.*—As a rule, operation for peptic ulcer brings about a cure, or at least marked relief, but in a small percentage of cases post-operative symptoms are sufficiently pronounced as to require exploration to determine the cause of the trouble. Operation may reveal merely adhesions, or disease of an adjacent viscus—the gall-bladder, liver, pancreas, or appendix—may be found. Or the symptoms may be due to a functional disorder arising in the vegetative nervous system, of which we know so little. Sometimes the blame can be laid on the enterostomy stoma, which being too small interferes with proper emptying of the stomach contents, or if too large predisposes to regurgitation of bile and intestinal secretion and gastric contents, thus producing the burning sensation and gaseous eructations for the relief of which the patient once more presents himself to the surgeon. There is, however, one group of patients who may be symptom-free for many months and then experience the old “burning, gnawing distress in the epigastrium,” that leads to the suspicion of the presence of another ulcer or a marginal ulcer.

Vicious circle, or as Peterson better describes it, “gastric ileus” since anterior gastro-jejunostomy has been replaced by posterior anastomosis, may occur in four different ways: from the back-flow of duodenal contents through an open pylorus; regurgitation through the proximal loop; the gastric contents may move into the proximal instead of the distal loop, and then be regurgitated through the pyloric opening; lastly, back-flow from the distal jejunal loop. From our X-ray studies of the function of the gastro-jejunal

stoma, we find that in the same patient, the food sometimes passes through the new opening and sometimes through the pylorus, so that a percentage of cases are seen in whom the symptoms apparently subside when the gastro-jejunos-tomy is closed, the pylorus not having been materially altered surgically. With the ptotic type of stomach, gastro-enterostomy is not always successful and recurrence of symptoms is apt to follow after operation. Sometimes also a normally situated stomach may tend to sag when the jejunum is joined to it, if the lesser omentum is too elastic. In a word, the greater the pathologic changes at the first operation, the safer is the gastro-enterostomy as regards later functional disturbances.

*Marginal Ulcer.*—Gastro-jejunos-tomy is not a cure-all for peptic ulcer; nor is subtotal gastrectomy; nor is pyloroplasty. I have seen ulcers recur following each of these procedures. The general impression, as I interpret it, is that marginal ulcers occur more frequently following gastro-jejunos-tomy than after gastric resection. Statistics are extremely variable. In a series of two hundred and forty-seven cases operated in the Lankenau Clinic, there were fifty-three gastric ulcers, one hundred and seventy-four duodenal ulcers, and twenty marginal ulcers. Our records show four recurrent ulcers after gastric ulcer, seven marginal ulcers following duodenal ulcers (4.5 per cent.), while in eleven (operated elsewhere) it was impossible to ascertain the type of ulcer originally present. The shortest time between operation for ulcer (duodenal) and marginal ulcer was one year and five months—the longest time fourteen years (the first operation having been performed for a perforated gastric ulcer at which time a posterior gastro-enterostomy had been done).

Marginal ulcer is a very real surgical entity. So long as gastro-jejunos-tomy is performed we subject the patient to the risk of this recurrent ulcer. Haberer believes it occurs more frequently after posterior gastro-jejunos-tomy with a short loop, and therefore advocates subtotal gastrectomy for all cases of peptic ulcer. But he also has seen marginal ulcer develop after the radical operation. Marginal ulcers, as we all know also perforate. Since they are distant from the solid viscera, the perforation permits the free discharge of gastric contents into the peritoneal cavity, which, when the ulceration involves the colon, produces a gastro-jejuno-colic fistula. We have recently had three such instances.

Some of the possible factors in the causation of marginal ulcer are infection, improper suture, mechanical injury, circular spasm of the gastric or duodenal musculature, retrograde discharge of the jejunum into the stomach; failure of neutralization of the gastric juice by the duodenal fluid and the action of the hydrochloric acid on the jejunal mucosa. We agree with Reimann as to the importance of two factors: first, injury to the mucosa, and secondly, the eroding, digestive action of the gastric juice. Symptomatically, as a rule, there is pain either in the epigastrium or the hypogastrium, or a gastric hemorrhage may be the first evidence of the trouble. X-ray may



or may not be of value in diagnosis while analysis of gastric contents is of little utility in these cases. The diagnosis is made principally on the history of typical pain, confirmed when possible by röntgenologic studies. In the light of our present knowledge the question naturally arises what measures taken at the primary operation will minimize the possibility for marginal ulcer to develop? As already stated, I believe the principal factors in its causation are injury followed by the digestive action of gastric juice, acting at the line of suture. Therefore the guiding principle is, as little trauma as possible, control of minute bleeding, handling tissues with rubber-tipped forceps, absence of traction, etc. In addition to this, let me state that in no realm of medicine is coöperation between the internist and the surgeon more important than in the after-care of peptic ulcer cases. The proper kind and amount of food, and holding the patient to this strict diet over a considerable period of time are absolutely essential. Administration of alkalis is also desirable for those patients who have gaseous eructations, belching, and mild distress. The operation is but one phase in the treatment of these cases. Disregard of the other features in treating them may lead to unpleasant complications.

From what we know about peptic ulcer and because of a certain degree of uncertainty as to the results obtained by secondary surgery, I advise dietary regulation and medical treatment in selected cases in whom the symptoms arouse the suspicion of secondary ulcer. I have referred many of these patients to my medical colleagues and have seen complete relief of symptoms in a number of instances; at any rate, if operation is advised later on, the patient is in better condition for it. One cannot be dogmatic. Success lies in individualization of each case. Prolonged medical treatment with no relief is as bad a practice as immediate operation on every case. For gastric ulcer the consensus of experienced surgical opinion favors surgery in every case because of its ominous possibilities, but duodenal ulcer is a problem which the internist and surgeon should solve together. As C. H. Mayo aptly states: "For the good of the patient there should be harmony of consultation, discussion and decision as to the method of treatment . . ."

*Inguinal Hernia.*—Recurrence following inguinal herniorrhaphy is another major problem with which the surgeon of to-day has to deal. Recently a patient operated one year previously for inguinal hernia returned to our Follow-up Clinic with a recurrence of the hernia. He desired to know whether following another operation the probability of recurrence would be greater, the same, or less than existed after the first operation. We replied that our statistics indicate that recurrence after a second operation for hernia took place in approximately five per cent. of cases. Statistics of different clinics vary greatly in the percentage of recurrences following inguinal herniorrhaphy. In the last five years nine hundred and twenty-six cases were operated in the Lankenau Clinic for inguinal hernia, of these one hundred and two (11 per cent.) were recurrent cases. In the last sixty cases fifty-four



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occurred in males, six in females and forty-two of the sixty had been operated elsewhere for the primary operation. The division between right and left inguinal hernia was approximately equal.

Recurrence of an inguinal hernia following operation depends on several factors: (1) type of hernia, (2) degree of hernia, (3) substantiability of involved structures, congenital predisposition, and age of patient, (4) type of primary operation (including type of anæsthesia and suture materials used), (5) infection at primary operation, (6) after-care—daily routine following release from hospital.

Direct herniæ are found in about five per cent. of all inguinal herniæ, and they recur more frequently than the indirect type because "buffer tissues" to the intra-abdominal force are more difficult to secure and retain in place. Coley states that recurrence in ninety per cent. of cases takes place within the first year, and furthermore, if the tissues hold firm for a year they will probably remain so.

The size of the primary hernial sac gives a certain clue to prognosis: for the larger the sac, the wider and more loose the tissues surrounding the internal ring, the more likely is recurrence to take place since the "stage is set."

An important factor in recurrence is the stability of the anatomic structures in the region of the rings and the inguinal canal. Each exit from the abdomen through the abdominal wall represents a potential hernia. Many surgeons believe certain individuals exhibit a predisposition to hernia. This may be explained by the tissues which give way, the age of the patient (to a minor degree) and his work, together with such factors as continued increase in intra-abdominal pressure from constipation, heavy lifting, etc. Continued pressure from a truss-pad causes atrophy and fatty degeneration of muscle fibres, a condition which may also exist in elderly patients without the presence of a truss. A patient whose musculature elsewhere is well developed may possess yielding fibres in the inguinal region. Anatomic variations probably also account for a certain number of recurrences. Bloodgood and Hessert, independently, have called attention to cases in which the conjoined tendon was either attenuated or absent, an important condition in the development and recurrence of direct hernia, since the lower angle of the canal is thus deprived of its strongest support. Hessert in these cases has noted developmental defects of the external oblique fascia with an abnormally large external ring. The absence of the conjoined tendon, according to a report by Taylor, accounts for thirty-seven and one-half per cent. of recurrences.

With the proper repair of the primary hernia the possibility of recurrence is of course reduced to a minimum. By proper repair we mean knowledge of the forces which produced the sac, an appreciation of the weakness of the anatomic structures which are sometimes included, and too greatly relied upon in making the repair, the selection of proper suture materials, and the absence of infection. The parts should be restored as nearly as possible to

the normal. The disposition of the cord is of no especial importance so long as its function is not impaired. The sac is freed, the peritoneum separated for some distance at the site of the internal ring, by blunt dissection, put on tension, tied off as high up as possible, and then cut off. Some operators advocate anchoring the stump to the overlying muscle, displacing it, and furnishing a sufficient buffer against which the intra-abdominal force is exerted but which it, presumably, cannot overcome. Scarification may favor the formation of supporting adhesions between the stump and the muscle fibres.

The success of herniorrhaphy depends on the formation of a permanent cicatricial union between the structures in this region. Since many experiments apparently prove that tendon and muscle will not unite, whereas union of tendon to tendon is more trustworthy, many surgeons have used autoplasmic suture materials in the repair. Opinions differ as to the durability of these bands and in repeated instances they have become absorbed. I often use the Andrews' method of suturing tendon surfaces, thereby following the principle that surfaces hold while edges frequently separate; sometimes I create an aponeurotic canal for the cord, utilizing the tendonous flaps of the aponeurosis of the external oblique. The procedure of suturing muscle fibres of the internal oblique and transversalis muscles to the shelving margin of Poupart's ligament is of doubtful value, for with the absorption of the suture these structures may promptly separate.

Formerly infection of the wound at, or following operation was an important feature in the histories of recurrent herniæ. Improved technic, however, is minimizing this feature.

To my mind proper after-treatment is just as essential to a happy result as is the proper selection of the operation. Our patients are required to lie quietly in bed for fourteen days with the scrotum supported. Many surgeons advocate as long as three weeks of rest. Patients should be informed that recurrence may result from any sudden strain, such as lifting oneself in bed, repeated strain at stool, getting out of bed too soon, etc.

Convalescence must be very gradual and we have found the use of an elastic support to the lower abdomen of real value. Heavy lifting, horse-back riding, tennis and like pursuits should be abandoned for some time. On the other hand, graded exercises are necessary for the general well-being of the patient. The two principle features in the proper disposition of an inguinal hernia are high ligation of the sac and proper after-care.

A survey of cases subjected to operation a second time impresses upon me the tremendous importance of a painstaking, thorough study of each case before the primary operation is performed. We owe the patient the benefit of all necessary accessory clinical and laboratory tests, no matter how small, that may add to our security in diagnosis. Selection of the proper time for surgery and the best type of anæsthesia is important. At operation an exhaustive search for additional factors as, for example, the existence of a diverticulum in the wall of a urinary bladder opened for removal of an

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enlarged prostate gland, should always be made, otherwise the patient will continue to be distressed and a second operation will be necessary. Respect for tissues at all times, thoughtful and considerate post-operative medication and care, and a sustained interest in the patient carried out systematically by a Follow-up Service will diminish the number of secondary operations entered on hospital records. In the majority of the cases requiring repeated intervention someone is to blame. I have tried to show you the rôle the surgeon plays and to point out the pitfalls in his path; the other responsible party is the patient himself. By modern methods of publicity the laity are becoming educated in the symptomatology of the more common surgical diseases and patients are therefore more prompt in seeking professional care. Those who fail to do so increase their own risk and add to surgical morbidity and mortality.

# VALUE OF RADIOGRAPHIC CONTRAST SOLUTIONS IN THE STUDY OF BRAIN ABSCESS\*

BY EUGENE W. ROCKEY, M.D.  
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BRAIN abscess cases present many problems in treatment, not the least of which is the post-operative course after the original drainage has been instituted. A knowledge of the size, shape, and accurate location of the abscess cavity is of decided value. The only practical method by which



FIG. 1.—Radiograph before any operative procedure. Note rarification in parietal region.  
FIG. 2.—Antero-posterior view before operation; not diagnostic.

this knowledge can be acquired is by radiographic study after the injection of the cavity with a contrast solution.

Lipiodol, which is a 40 per cent. iodine solution in poppy seed oil, the use of which was first advocated by Sicard† of Paris in 1921, has probably been the most extensively used contrast solution in neurological studies. It is insoluble, and remains in any closed cavity as a foreign body. That it may cause irritation, and perhaps serious consequences, has been pointed out by William Sharpe‡. The leaving of any foreign body in the presence of infection would be doubly dangerous, and therefore to be avoided. A solution of sodium iodide is very soluble, and is rapidly absorbed. It furnishes an

\* Read before the Tri-County Medical Society at Salem, Oregon, February 15, 1927. Preliminary report of this study read before the North Pacific Surgical Association, Vancouver, B. C., December 10, 1926.

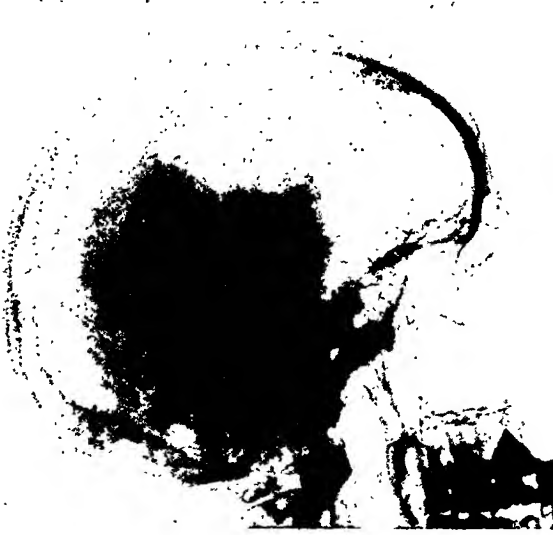
† Sicard, J. A., et Forestier: *Rev. Neurol.*, 1921, vol. vi, p. 1264.

‡ Sharpe, W., and Peterson, C. A.: *ANNALS OF SURGERY*, vol. lxxxiii, p. 32, January, 1926.

## RADIOGRAPHIC CONTRAST SOLUTIONS IN BRAIN ABSCESS

excellent contrast medium, and if injected without undue pressure in a cavity does not cause irritation. This does not refer to the thecal cavity.

In making the present study a 20 per cent. sodium iodide aqueous solution



3

FIG. 3.—Radiograph after the bone had been removed, exposing extra-dural abscess.



4

FIG. 4.—Lateral view one week after drainage of brain abscess. Cavity injected with sodium iodide solution.

was used. The results were so satisfactory and instructive that the procedure and findings seem to warrant a report. A search of the literature has failed to disclose the previous use of this method.

CASE.—A man, fifty-nine years old, referred by Dr. Harvey Parker. General health always very good. No paralysis. No mental impairment. When three years of age he sustained a compound fracture of the skull in the left parietal region. Since then



5

FIG. 5.—Antero-posterior view one week after drainage of brain abscess. Cavity injected with sodium iodide solution.



6

FIG. 6.—Lateral view of brain abscess cavity, injected with sodium iodide solution. This eleven days after previous radiograph. Comparison of this radiograph with Fig. 4 will show the diminution in size and change in shape of the cavity.

the scalp had always been tightly adherent to the skull in this region. Ten years ago the scalp had so thinned that a small point of bone projected through the skin. The thinned-out scalp was excised under local anesthesia, the projecting bone was chiselled

off, and a skin graft applied. In a like manner projecting points of bone were removed six and again five years ago.

In October, 1925, a small area of scalp in the left posterior parietal region developed



FIG. 7.—Antero-posterior view eleven days after radiograph, Fig. 8. Comparison with this shows the diminution in size and change in shape of the cavity.

FIG. 8.—Lateral view seven days after radiograph, Fig. 6. Note farther diminution in size, as I marked pinching off of upper cavity, leaving pit, sealed by a narrow skin.

a slightly raised-edged ulcer. This was diagnosed as an epithelioma, and was given one application of radium in November, 1925. No farther radium treatments were given. The healing was very slow, and was not complete until August, 1926.

In September, 1926, an area of scalp, 1½ x 1 inches in size, located half an inch in front of the area which had been treated with radium, became black and necrotic.

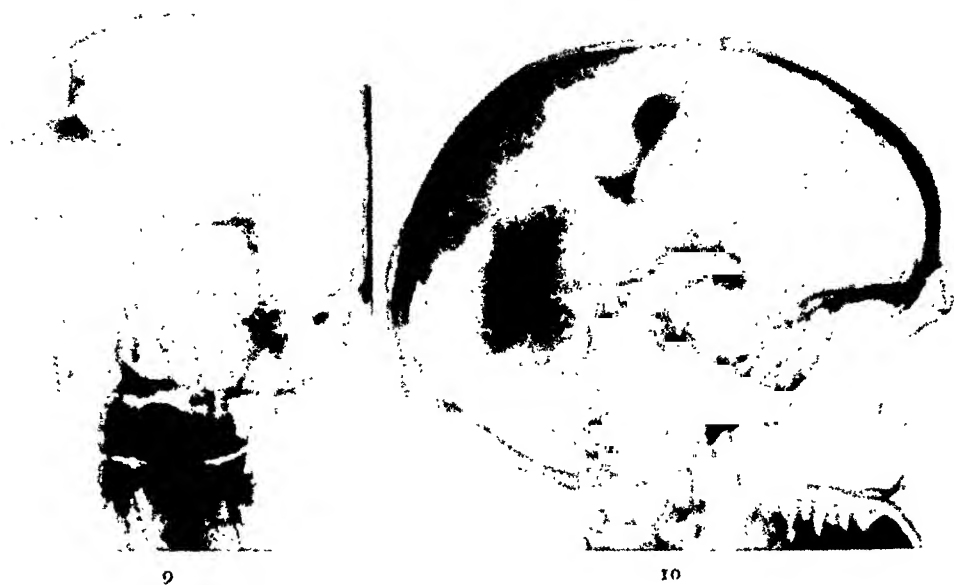


FIG. 9.—Antero-posterior view seven days after radiograph, Fig. 7. The pinching off of the upper cavity is definitely to be noted here.

FIG. 10.—Lateral view seven days after radiograph, Fig. 8. Note the marked closing in of the lower portion of the cavity with little change in the upper portion.

Doctor Parker, under whose observation he was at this time, expressed the opinion that this seemed to be an area of gangrene due to thrombosis of the vessels of the scalp. When this necrotic scalp came off the latter part of September, 1926, he had an intense

## RADIOGRAPHIC CONTRAST SOLUTIONS IN BRAIN ABSCESS

headache lasting two or three days. For the next three weeks he felt sick, and ran a fever, and had a moderately severe headache.

Examination October 22, 1926. A sick looking man. Temperature 102.5°. Pulse 90.



11



12

FIG. 11.—Antero-posterior view seven days after radiograph, Fig. 9. Note the decrease in size of the lower portion of the cavity without change in the upper portion.

FIG. 12.—Lateral view nine days after radiographs, Figs. 10 and 11. Very little sodium iodide could be injected. However, when this is compared with the previous radiograph it will be seen that some entered the upper cavity.

Local examination showed an area of bare, whitened skull,  $1\frac{1}{2} \times 1$  inches, in the left parietal region. The scalp for an inch in all directions, and two inches below the exposed area of skull, was red and swollen, evidently acutely inflamed.

He was put to bed, and massive hot, wet dressings of a saturated solution of boric



13



14

FIG. 13.—Antero-posterior view nine days after radiographs, Figs. 10 and 11. See note on Fig. 12. The picture taken with the head turned on the side. The definite fluid level of the sodium iodide, which entered the upper cavity, can easily be seen with the gas above it.

FIG. 14.—Lateral view without any sodium iodide injection. This and the following plate were made twenty-eight days after radiographs, Figs. 12 and 13, and after the patient had had an exacerbation of his old symptoms.

acid applied. In two days his headache had gone, and in four days his temperature had dropped to normal. He was allowed to be up and about. A few days later a

small abscess developed in the scalp just posterior to the denuded area. This was opened, and drained pus freely. He felt much better. His temperature remained normal. X-rays, see Figs. 1 and 2, showed an area of rarification roughly corresponding



15

16

FIG. 15.—Antero-posterior view without any sodium iodide injection. This and the preceding plate were made twenty-eight days after radiographs, Figs. 12 and 13, and after the patient had had an exacerbation of his old symptoms.

FIG. 16.—Lateral view four days after radiographs, Figs. 14 and 15. In the meanwhile the upper abscess cavity had been drained through a separate incision, and the present tube runs through the upper of the two openings. Sodium iodide injection.

to the denuded skull. Pus continued to drain very freely from the small scalp incision, so much so that we concluded that it must come from an abscess between the tables of the skull, or just within the skull.

November 5 he had a slight headache, and his temperature was  $101.6^{\circ}$ . There was no



17

18

FIG. 17.—Antero-posterior view four days after radiographs, Figs. 14 and 15. In the meanwhile the upper abscess cavity had been drained through a separate incision, and the present tube runs through the upper of the two openings. Note that none of the sodium iodide ran downward into the lower cavity.

FIG. 18.—Lateral view made immediately following the two preceding radiographs. In this case the tube has been introduced through the lower of the two openings, and some of the contrast solution still remains in the upper cavity.

paralysis, nor change in reflexes. He was sent to the hospital to be operated upon the following morning.



## RADIOGRAPHIC CONTRAST SOLUTIONS IN BRAIN ABSCESS

At 5 A.M., November 6, he awakened, and was unable to speak distinctly, and had difficulty in using his right hand and right leg, although he could move them. Four hours later under local anæsthesia an opening was made with a Hudson drill through the exposed bone. This entered an extra-dural, granulation lined, abscess cavity containing about 5 c.c. of creamy pus. In this pus there was a small loose piece of necrotic bone. The bony opening was enlarged with rongeurs to the limits of the cavity. There was no bulging of the dura, which pulsated normally. Smears and culture showed a non-hæmolytic streptococcus, not streptococcus viridans.

The granulation-covered dura, which was left fully exposed, continued to pulsate freely. His general condition improved, and for two days his speech was normal, and he was able to use his right hand almost normally.

November 12 he became rapidly worse, was unable to talk, and his right arm and leg became completely paralyzed. X-ray, see Fig. 3, was of little help. In the afternoon he became unconscious. His pulse was 90; temperature 100.4°. Eye grounds normal. There was no bulging of the dura.

November 13. In the early morning he was deeper in his unconsciousness. Pulse 108, and axillary 101.6°.

It was decided that there must be a deep brain abscess, in spite of the freely pulsating and retracted dura. At 10 A.M. a needle was introduced, pointed slightly upward and forward. At a depth of one inch 2 c.c. of slightly cloudy, yellowish fluid was obtained.

By 8 P.M. his condition was much worse. Pulse 120. Axillary temperature 102.8°. Respirations Cheyne-Stokes in character. Again a needle was passed through the same dural opening, this time directed horizontally and slightly backward. At a depth of  $\frac{5}{8}$  inch cloudy amber fluid was obtained, and after 1 c.c. had run out thick creamy pus came. A  $\frac{3}{16}$  inch diameter rubber tube was now introduced into the abscess cavity.

His general condition improved markedly, and by the following morning he was conscious. Aphasia was still complete.

November 20, one week following the drainage of his brain abscess, it was decided to make a contrast solution study of the abscess cavity. This was done by injecting a 20 per cent. aqueous solution of sodium iodide through a tube of similar size to the drainage tube, which was removed for the purpose. The injection and subsequent radiographs were made with his head turned on the side, so that the fluid would not run out. The injection was made with a syringe, but care was used to exert no undue pressure. Twelve c.c. entered the cavity. X-rays, Figs. 4 and 5, were made. The information thus obtained was of great value.

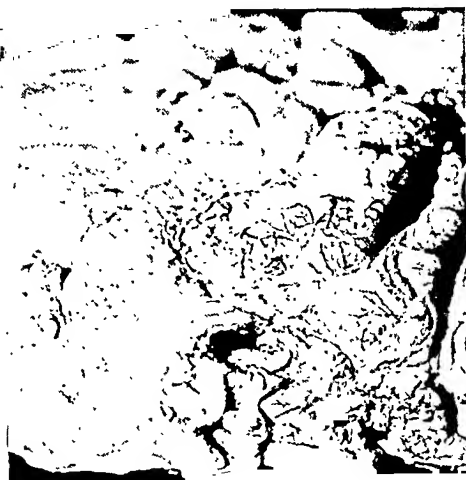
Neither at this time, nor with any of the following injections, were any untoward symptoms noted as the result of the sodium iodide injections.

Improvement was fairly constant from the time of the drainage of the abscess November 13 until January 22, 1927. November 21 there was pain in his right leg. November 24 motion returned in the right leg. December 1, see X-rays, Figs. 6 and 7, by this time he was able to say simple things, partial phrases. December 4, there was

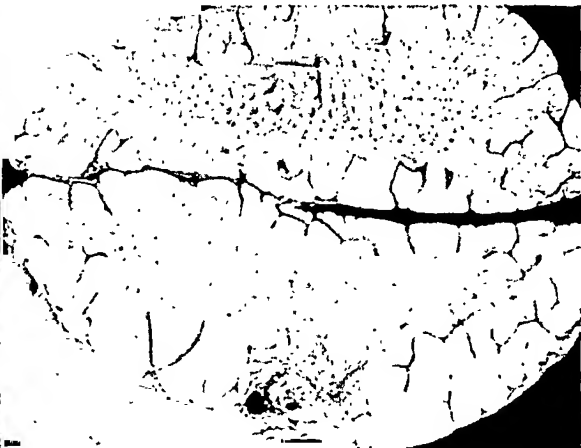


FIG. 19.—Antero-posterior view made immediately following radiographs, Figs. 16 and 17. In this case the tube has been introduced through the lower of the two openings, and some of the contrast solution still remains in the upper cavity.

pain in the right hand and arm. He was up each day in a wheel chair. December 8, there was slight motion in the right index finger. His temperature had been normal for a week. He was clear mentally. He could speak at times whole sentences, although at



20



21

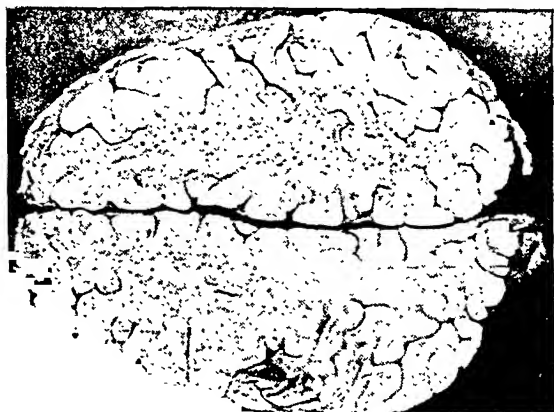
FIG. 20.—Close-up view of outside of brain, showing the two drainage holes, and showing the plastic exudate on the meninges.

FIG. 21.—Section through brain at level of abscess cavity. The hole made by the drainage tube is open, but there is no abscess cavity as such. Careful inspection will show the location of the arm of the cavity, which ran backward and inward.

other times his aphasia was still marked. See X-rays, Figs. 8 and 9, showing a continued decrease in size of the cavity.

It is to be noted that the upper arm of the cavity was being narrowed down very rapidly in the form of a pedicle, leaving a bulbous area above it. At this time a preliminary report of this case was read, and the following statement was made. "A continuation of these X-ray studies will be made, and should the healing pinch off the upper arm, leaving an isolated, undrained abscess, it will be of great value to know just where this is, so it can be reached with the minimum of trauma."

Figures 10 and 11 show a marked closing in the lower portion of the cavity without



22



23

FIG. 22.—Section of brain at one-quarter inch higher level than preceding section. Note how healing of the abscess cavities has taken place.

FIG. 23.—Section of brain at one-quarter inch higher level than preceding section. Again note the healing of the abscess cavities.

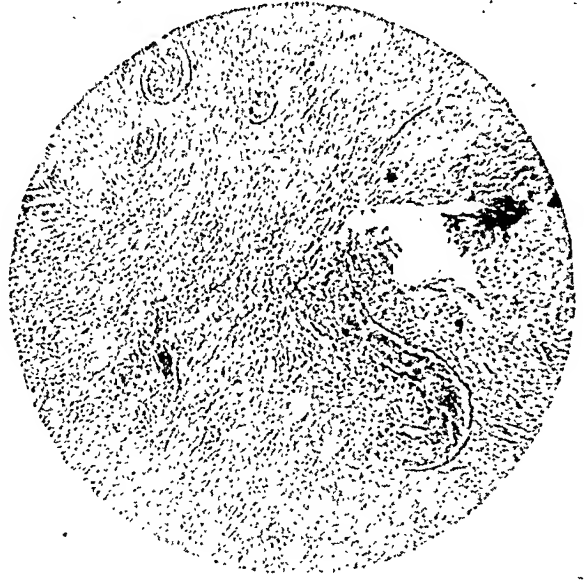
change in the upper portion. Figures 9 and 10 show that the lower portion had closed in to a minute sinus, but that the upper portion, or cavity, still remained. Little sodium iodide entered.

## RADIOGRAPHIC CONTRAST SOLUTIONS IN BRAIN ABSCESS

Clinical improvement was marked. He was able to be up, and walk about. He was entirely clear mentally. Motion had returned in the right hand, so that he could flex and extend all of the fingers, and thumb, and supinate and pronate the forearm,



24



25

FIG. 24.—Abscess wall reveals extensive diffusion of red blood-cells and polymorphonuclear neutrophilic infiltration.

FIG. 25.—Dilated vessels in immediate wall of abscess, also inflammatory cell reaction.

but he was not able to make finer motions. His aphasia had become much less marked, and he was able to make himself fully understood, and at times he could speak quite distinctly. The drainage tube was kept in place all this period of time, but gradually shortened during the week preceding January 22. On the morning of the 22nd it was found in the dressing, and no attempt was made to replace it. There had been very little drainage for this past week.

On the afternoon of January 22 he became very irritable, and complained of headache. By the following afternoon his temperature had risen to  $102.8^{\circ}$ . The paralysis had again become complete in the right arm and right leg. There were definite twitchings in all extremities. The neck was not stiff, and the legs could be freely extended when the thighs were flexed on the body. The drainage tube was re-introduced into the sinus, but no accumulation of pus found. A needle was introduced through a newly made opening in the exposed dura at a point that was apparently directly over the upper pinched-off abscess cavity as shown in the radiographs. However, no pus was found. He seemed better for two days, and then became unconscious with Cheyne-Stokes respiration. There was still no rigidity of the neck, and Kernig's sign was absent. Again a large needle was introduced through the recently made opening in the dura, and this time at a depth of  $\frac{1}{4}$  inch an abscess cavity was entered, and creamy pus evacuated. A drainage tube was introduced.

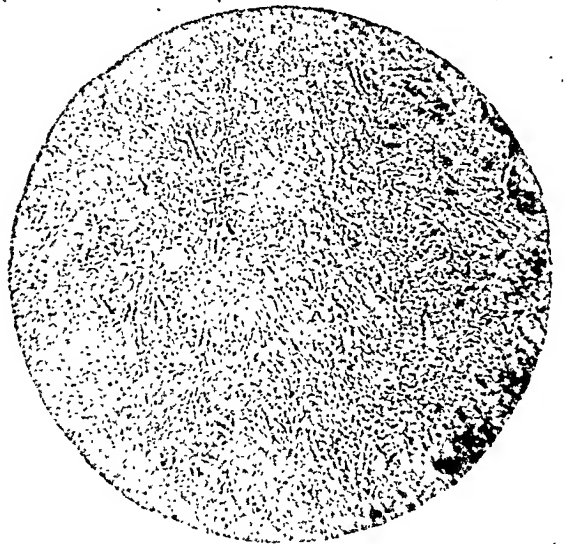


FIG. 26.—Shading of inflammatory process from abscess wall into brain tissue.

In Figs. 16 and 17 we see the sodium iodide solution introduced through the newly made opening into the upper cavity. Note that none of the sodium iodide solution runs downward toward the old drainage tract. Figures 18 and 19 show the injection made into the lower cavity immediately after the previous injection had been made. Some of the iodide solution still remained in the upper cavity.

He became progressively worse, temperature, pulse, and respiration gradually rising until death. At no time was there rigidity of the neck, nor a positive Kernig's sign. Blood culture was negative.

Autopsy done by Dr. C. H. Manlove disclosed a meningitis which had evidently involved the left parietal region for a period of some days (see Fig. 20), and then become generalized. This was the cause of death.

Sections through the brain showed that the abscess cavities were well drained, and that there had been no great destruction of brain tissue, see Figs. 21, 22, and 23. Microscopic sections, see Figs. 24, 25, and 26, show distinct organization and repair with a thin abscess cavity wall.

*Comment.*—The possibilities of the value of sodium iodide radiographs of a brain abscess are well exemplified here. We are able definitely to know the location, size, and shape of the abscess cavity, and to study the manner in which healing takes place. Also in addition to the value in the individual case, similar studies of other brain abscesses may add to our knowledge of this subject.

# A METHOD OF REMOVING DISCRETE ADENOMATA OF THE THYROID

BY FRANK H. LAHEY, M.D.  
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THE removal of discrete adenomata of the thyroid is technically the simplest and safest procedure of all the operative procedures performed upon the thyroid gland. One deals only with a definitely encapsulated tumor in a patient usually devoid of marked toxicity and as a rule in good general condition. Mortality of operative removal in 1093 patients with discrete adenomata of thyroid in our hands has been fifty-six hundredths of one per cent. This mortality rate covers all types of discrete adenomata of thyroid at all ages, those with congestive heart failure and those of intrathoracic location. It is evident, therefore, that operative risk of removals of this type of goitre is not great.

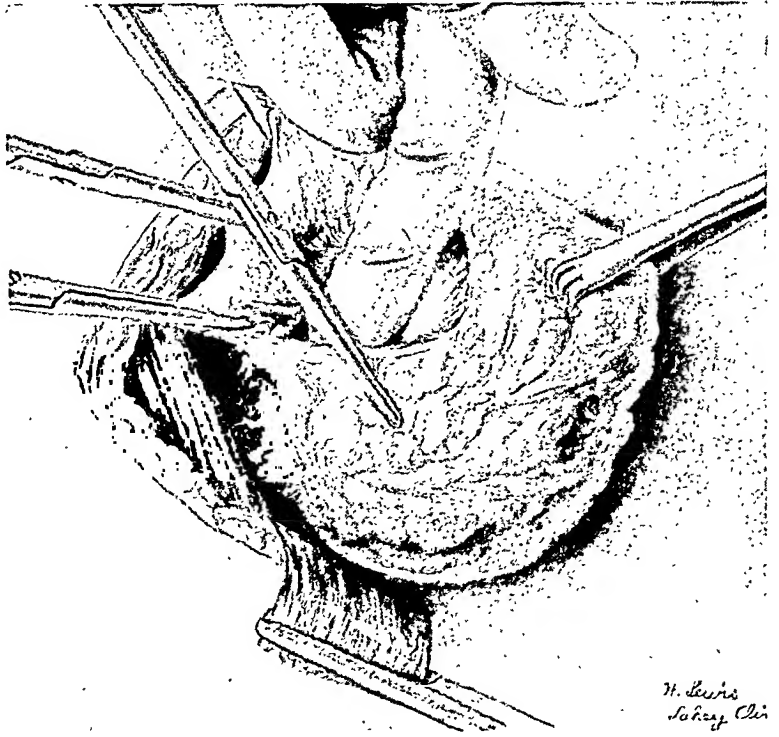


FIG. 1.—This was the plan employed for several years in removing discrete adenomata of the thyroid. Its disadvantage is the amount of bleeding which follows blunt separation of the adenoma from thyroid tissue and the fact that the small vessels which run from the thyroid to the adenoma when torn retract into the posterior shell of the thyroid tissue so that they are difficult to catch without pushing the points of the hæmostats well down into the posterior shell of thyroid tissue.

The gravest danger in this type of goitre, in our experience, has been that of injury to the recurrent laryngeal nerve and injury to the inferior parathyroid body on the operative side.

Discrete adenomata of the thyroid are almost always located on one or both lobes of the thyroid. Occasionally they do arise in the isthmus and remain located in the middle line, but due to the median prominence of the semi-rigid trachea, together with the counter-pressure of the perithyroid muscles, even though they arise in the portion of the thyroid which is at or close to the median line, they tend as they increase in size always to be guided eventually into a lateral position on either lobe beside the trachea.

As the adenomata increase in size, they gradually encroach upon the substance of the lobe, particularly as relates to the body of the lobe, until as enlargement of the adenoma goes on, an increasingly thinner layer of thyroid

tissue covers the posterior aspect of the discrete adenoma. (The thin layer of thyroid tissue may be noted in Fig. 3.)

It is because of the thinness of this layer of thyroid tissue covering the

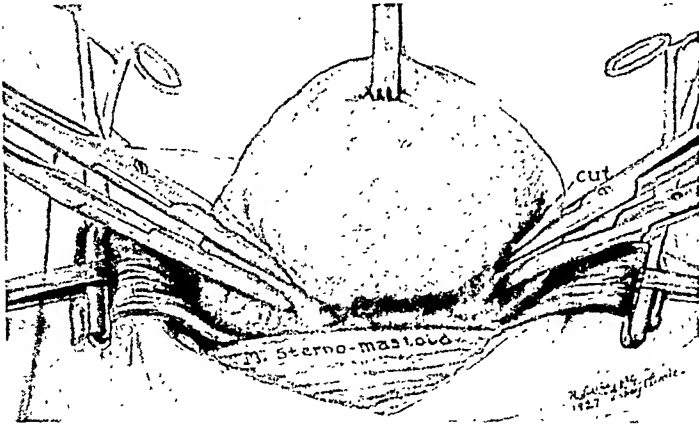


FIG. 2.—The application of Ochsner clamps above and below the adenoma. The clamps should be applied both above and below as close to the adenoma as is possible without including any of the capsule of the adenoma in their grasp. If this be done carefully, when the incision between the clamps and the adenoma is made the release of tension over the adenoma causes its capsule to bulge out prominently through the over laying layer of thyroid tissue. (See Fig. 3.)

the securing of those vessels that the hæmostats and sutures used to catch them not infrequently penetrate this thin layer of thyroid tissue and include the

posterior aspect of the adenoma of the thyroid that the recurrent laryngeal nerve and the inferior parathyroid are so commonly injured in the removal of discrete adenomata. As the adenoma is shelled out and separated from this covering of true thyroid tissue, numerous small vessels are torn together with two or three fairly large branches of the inferior thyroid. It is in

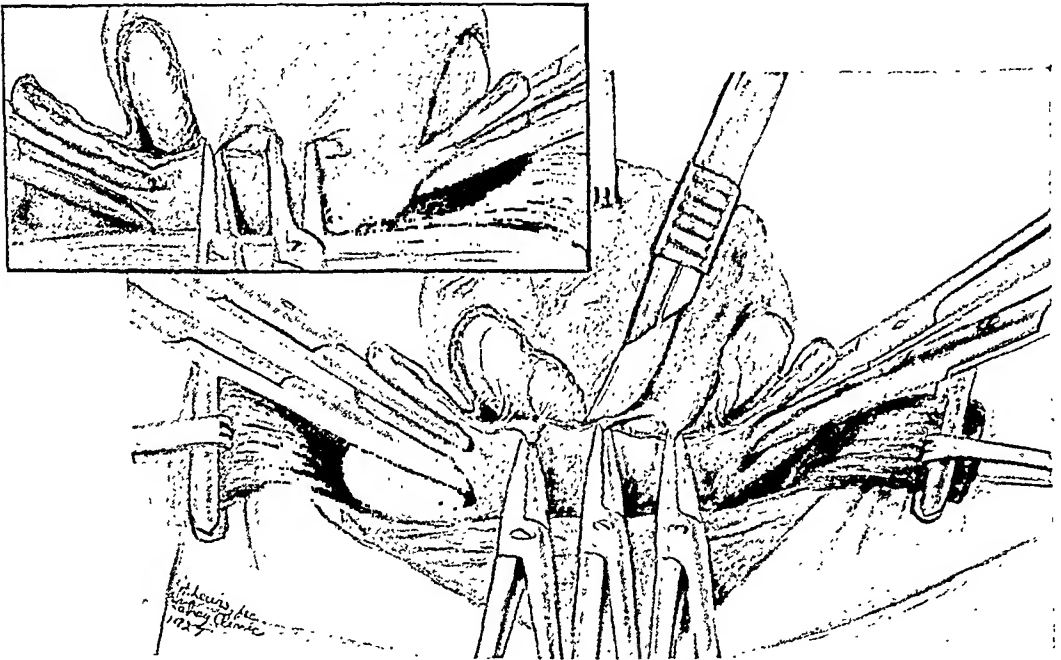


FIG. 3.—Incisions have been made above and below between the Ochsner clamps and the adenoma. The clamps have been applied so closely that when these incisions are made the walls of the adenoma bulge out through the thin layer of overlying thyroid tissue. This drawing also shows the method of applying the two or three hæmostats so that they grasp only the thin layer of overlying thyroid and the method of cutting away these bits of tissue without injuring the capsule of the adenoma.

nerve or the blood supply of the inferior parathyroid in their grasp, resulting in laryngeal paralysis and loss of inferior parathyroid body on operated side.

We have had this occur in our own experience, and have so frequently seen one-sided recurrent laryngeal paralysis following removal of a discrete adenoma elsewhere, that we are of the opinion that injury to the nerve is not an uncommon complication of removal of a large discrete adenoma of the thyroid occupying a large part of one of the thyroid lobes.

Because of the danger of the above-described complications, we have gradually developed a technic for the removal of those discrete adenomata which now for some years has proven satisfactory in preventing such complications in the removal of

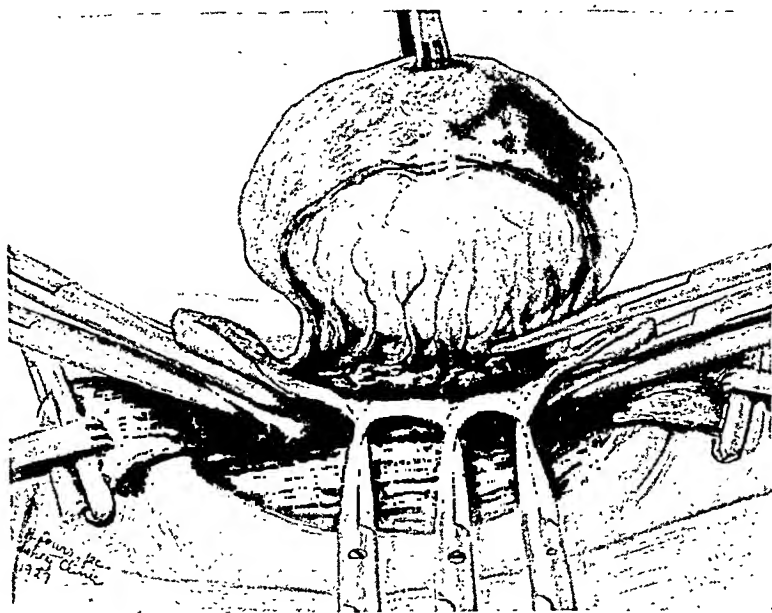


FIG. 4.—Showing the adenoma rotated inward to demonstrate the small vessels running from the posterior layer of thyroid tissue to the adenoma and the method of catching them in hæmostats while on the stretch.

these tumors. An Ochsner clamp is applied to the superior portion of the gland near the upper pole just outside that portion of the thyroid occupied

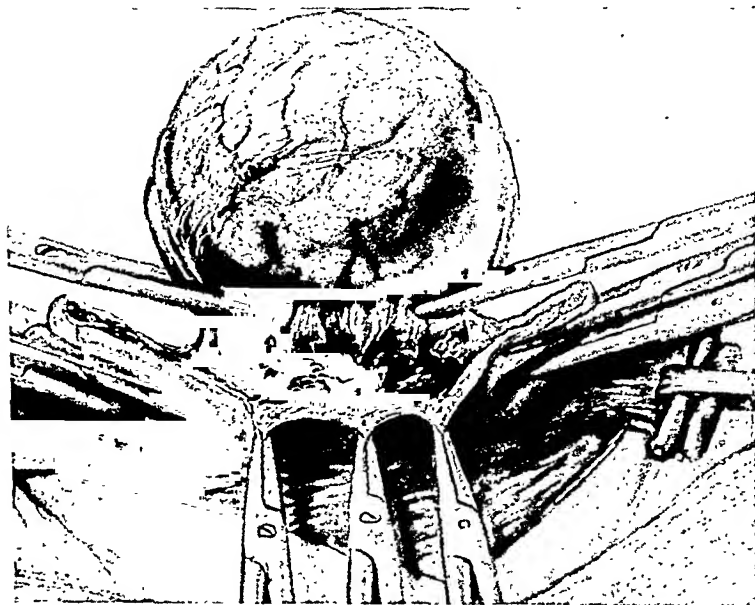


FIG. 5.—The adenoma has now been rotated well inward, so that it hangs only by the inner thin layer of thyroid tissue which covers the tumor. The vessels running between the adenoma and the posterior layer of thyroid tissue have been clamped and cut and the inner layer of thyroid tissue is being clamped preparatory to being cut away.

by the adenoma. This procedure of clamping through the substance of the gland at the upper pole in discrete adenomata was first described by Halstead several years ago, and was the plan which we employed for several years. The finger was inserted between the fibrous capsule of the adenoma and the (Fig. 1) overlaying layer of thyroid tissue; gradually separating one layer from the other and clamping as the separation was continued. The

disadvantage of this procedure was the amount of bleeding which resulted from the blunt separation of the adenoma from its bed of thyroid tissue.

The application of an Ochsner clamp to the portion of the thyroid below

the adenoma and, similar to the Halstead procedure above the adenoma, was employed and the thyroid tissue caught in the grasp of the upper and lower clamps cut through with a knife. When this is done the adenoma is left attached only by its overlaying thyroid tissue at its most posterior aspect. (Fig. 2.)

Hæmostats are then made to delicately grasp the thin layer of thyroid over this portion of the adenoma fairly well up upon its lateral wall above the

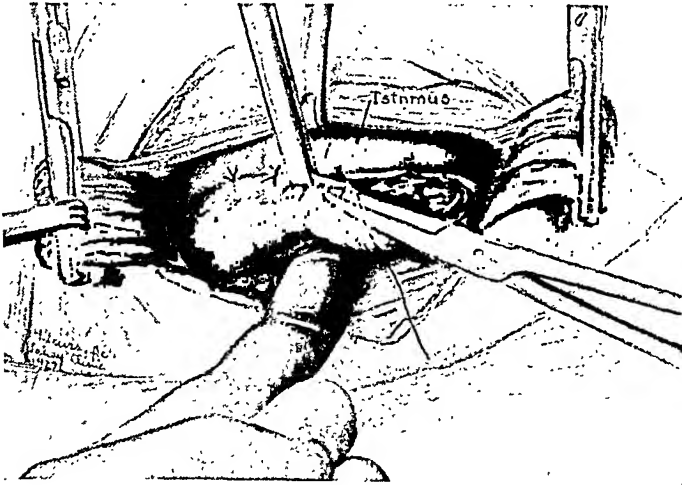


FIG. 6.—The upper and lower Ochsner clamps have been ligated and the external edge of the cut layer of thyroid tissue is being sutured to the inner cut edge to close the defect in the thyroid lobe.

usual location of the inferior parathyroid, care being taken to be certain that the points of the hæmostats do not penetrate the fibrous capsule of the adenoma. (Fig. 3.)

If these clamps are properly applied and the true thyroid tissue in their grasps cut with a sharp knife without injury to the capsule of the adenoma, the entire layer of thyroid tissue over-

laying the posterior aspect of the gland will be within their grasps, and by pulling outward upon the clamps and inward upon the adenoma, the vessels passing from the overlaying layer of thyroid tissue to the posterior surface of the adenoma may be caught with clamps and the entire thickness of the posterior layer of true thyroid tissue preserved. (Fig. 4.)

When all of the vessels passing from the posterior layer of thyroid tissue to the adenoma have been caught and cut, the adenoma will then be free except for the thin shell of thyroid tissue attached at the isthmus. This may be clamped with two or three hæmostats and the adenoma cut away. (Fig. 5.)

When the adenoma has been removed and the vessels tied, the median and external cut edges of the shell of thyroid tissue are united to close the defect in the thyroid. (Fig. 6.)

The technical plan here described has in our hands protected the recurrent laryngeal nerve and the inferior parathyroid body. It has lessened the amount of bleeding and has simplified the procedure of the removal of these discrete adenomata.



# BILATERAL ATELECTASIS (MASSIVE COLLAPSE) OF LUNG

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AND

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SUDDEN death during operation, with autopsy findings of massive collapse of the lungs, is the essence of the two cases we report.

That massive collapse of the lungs occurs has been recognized clinically and pathologically, as a review of the literature will show. That it has occurred as a sudden acute and tragic complication during operation, we have not hitherto found reported.

CASE I.—A married white female, forty-four years of age, was admitted to the Second Surgical Division, Bellevue Hospital, September 21, 1926. She complained of pains in the lower abdomen and of a vaginal discharge. Both the above complaints had existed for six months preceding admission. Her father died of pernicious anæmia. Her mother, two sisters and one brother are living and well. She had been married twenty-three years, had two children, both living and well, aged twenty-two and seventeen, respectively. No history of miscarriages. Patient had always been well until six months before admission, when she noticed a feeling as of something falling down in the pelvis. This sensation was accentuated on exertion.

Examination showed a polypoid mass, about  $3 \times 3 \times 2$  cm., protruding from the vulva. It was red and bled easily. It was attached by a narrow pedicle to the anterior wall of the cervical canal, near the external os, which was large and patulous. The fundus of the uterus was large and retroverted. It seemed bound down to the hollow of the sacrum.

*Heart and lungs* were carefully examined and noted to be negative.

*Pre-operative Diagnosis.*—*Fibromyomata of uterus.*

September 24, the polypoid mass was excised, followed by supravaginal hysterectomy through a suprapubic incision.

Appendectomy was also performed.

Abdomen closed in layers.

As the last sutures of the abdominal wound were being tied, it was noticed that the patient had stopped breathing. All attempts at resuscitation, including artificial respiration, dilation of the sphincter ani, injection of adrenalin into the heart, the use of the pulmotor, etc., failed, and the patient was pronounced dead.

*At Autopsy.*—Left lung collapsed; right lung partially collapsed, moderately engorged; no food in bronchi; tongue natural. Fairly well-marked laryngeal œdema. The epiglottis was peculiar in shape; no obstruction by food.

Heart and abdominal organs normal.

*Histological findings* reported as follows by Doctors Symmers, Miles and McGrath.

Examination of microscopic preparations from the collapsed pulmonary lobes reveals a tissue which it is difficult to recognize as lung, resembling rather a solid organ. This appearance is found to be due to complete atelectasis of the pulmonary alveoli, the epithelial cells of which lie closely packed together, having lost entirely their normal alveolar arrangement. The individual cells are swollen, certain of them being obviously hydropic, and the cell outlines are rather indistinct.

The bronchioles are also collapsed for the most part, many of them being represented merely by circular clumps of cuboidal cells.

The capillaries, arterioles and venules, on the other hand, are all uniformly dilated and filled with blood, producing almost an angiomatous appearance in certain areas. This constitutes the most characteristic feature of the histology of the condition.

CASE II.—A man, age sixty-nine, was admitted March 12, 1926, to the Surgical Service of the Brooklyn Hospital.

*Chief Complaint.*—Pain and swelling in left abdomen.

For nine years he had suffered from slight abdominal pain. One and a half years before had sharp abdominal pain and passed bloody urine. November, 1925, began to get short of breath and thought upper left abdomen had been getting larger. Personal

and family history negative.

*Physical Examination.*—

Distended abdomen. Tumor mass in left abdomen, 6 inches below costal margin. Seems posterior; moves slightly with respiration.

*Urine.*—Faint trace of albumin; red blood-cells, 3,700,000; 63 per cent. hæmoglobin; white blood-cells, 2000; 40 per cent. lymphocytes; Wassermann negative; temperature, 99 to 101 degrees.

*Clinical Diagnosis.*—Banti's disease; kidney tumor; aleukæmic leukæmia?

*Operation, March 19, 1926.*—G. O. ether used. Duration of anæsthesia 65 minutes; one-half ounce ether used.



FIG. 1.—Photomicrograph, lung section, Case I.

*Operation.*—Left rectus incision. Large spleen from crest of ilium to within two inches of midline. Very adherent and much trouble from oozing. Packs placed against liver. Wound closed. Saline clysis before end of operation and transfusion under way as operation ended. Patient apparently in shock, but improved under transfusion. Suddenly respiration stopped. Artificial respiration and stimulants without avail. Pulse perceptible at least ten minutes after respiration had ceased. Patient pronounced dead one hour after end of operation.

*Autopsy.*—One and one-half hours post-mortem. Peritoneal cavity contained about 50 c.c. free blood. Diaphragm at upper border of fourth ribs, both sides. No defect in diaphragm. No free pleural fluid. Serous surfaces smooth and glistening. Both lungs collapsed and lying close to vertebræ. They formed small, flat organs, each weighing about 50 gms. Only a small portion of each apex was crepitant. Rest of lung tissue firm and non-crepitant. On section the tissue was firm and homogeneous, pink in color. Pulmonary vessels empty. No secretion of bronchi. Heart weighed 300 gms.; contracted; otherwise negative.

Pulmonary atelectasis (massive collapse) has come to be recognized in recent years as a not uncommon complication after operations on the chest and abdomen, occurring rarely, if ever, after surgery confined to the extremities. The earlier work of W. Posteur in the first and second decades of this

century laid the foundation for its recognition as a definite clinical entity and stimulated the interest of others. The later writings of Elliot and Dingley, Bradford, Scrimger, Elwyn, Scott, Churchill, and others have served to arouse a fairly general interest among surgeons in this condition.

The occurrence of suddenly or rapidly developing respiratory distress, accompanied by cough, increased temperature, pulse and respiration, and at times by cyanosis, coming on from a few hours to a few days after operation, should lead the surgeon to look for atelectasis. The invariable physical sign of the condition is a displacement of the heart and the mediastinum toward the atelectatic lung. This can best be demonstrated by X-ray examination of the chest, though in most cases it is also demonstrable clinically. The signs over the affected lung vary greatly, depending on the extent and completeness of the collapse and the amount of moisture present in the lung.

While post-operative atelectasis has become well recognized as a clinical entity, the question of its etiology remains decidedly obscure. This may be due in part to the fact that the pathological data obtained to date is very meagre. It is a fairly benign surgical complication. Most of the cases improve very rapidly and recover completely, the number coming to necropsy being thus far very small. A number of theories have been advanced to explain the condition. These may be briefly summarized as follows:

1. *The Paralytic Theory.*—W. Pasteur believed massive collapse to be the result of paralysis or inhibition of the muscular forces expanding the lung. He says, "Whenever—whether as the result of paralysis or of reflex inhibition of muscular action—the distending force acting on the lungs becomes less than that of the elastic and muscular agencies which tend to cause its contraction, the latter, so to speak, takes charge, with the result that the affected portion of the lung rapidly empties itself of its contained air." He points out that immobility of the diaphragm may be due to (a) Paralysis. (b) Reflex inhibition caused by: (1) Inflammation. (2) Pain. This theory is not sustained by the results of experimental paralyses of the diaphragm, and does not seem adequate.

2. *The Obstructive Theory.*—It is of course known that when a bronchus becomes completely occluded by a foreign body the alveoli supplied by it lose the air they contain by absorption and atelectasis results. Chevalier Jackson has shown that diphtheria cases in which bronchi have become plugged with membrane sometimes show the same clinical and X-ray findings as cases of post-operative massive atelectasis. The great majority of post-operative cases cannot, however, be explained on such grounds.

3. *The Theory of Combined Obstruction and Impaired Respiratory Force.*—Elliot and Dingley, in reporting eleven cases, draw attention to the fact that they all show muco-purulent sputum and fever. Churchill concurs with them in the opinion that "Collapse is the result of a combination of obstruction of the bronchioles by inflammatory œdema and secretion and reflex immobility of the diaphragm." He goes so far as to say that bronchial obstruction is essential for the production of massive collapse. He further

suggests that obstruction of a bronchus may occur through compression of an adjacent patch of broncho-pneumonia. It is his opinion that in some cases the element of obstruction may predominate, while in others the dominant factor is diminished respiratory force.

4. *The Postural Theory*.—Briscoe disagrees with Elliot and Dingley as to obstruction being an essential element of massive collapse etiology. He believes that "collapse of the lower lobes is a natural sequence of prolonged quiet breathing in the supine position in such patients as do not use the abdominal muscles to fix their chests." In this connection it is an interesting



FIG. 2.—Photomicrograph, lung section, Case I.

fact that during the war many cases of massive atelectasis were noted in men who had superficial wounds of the *opposite* chest wall. These men naturally lay on the uninjured side, their weight tending to inhibit the motions of that side of the chest.

5. *The Vasomotor Theory*.—Gwyn mentions the possibility of massive atelectasis being due to some vasomotor cause. Scott, in the summary of his excellent article, says: "The mechanism of massive

atelectasis appears to be a reflex blocking of the finer air passages in the affected lung tissue, quite possibly of vasomotor origin. The fact that atelectasis can be produced in the lungs of frogs by vagus stimulation lends color to this theory."

6. *The Theory of Reflex Spasm of the Bronchioles*.—It is conceivable that spasm of the bronchioles might close them off and allow the absorption of the alveolar air. We know, however, that in asthma, where the bronchioles are in spasm, the result is the opposite of atelectasis, namely emphysema.

7. *The Angioneurotic Theory*.—It has been suggested that the condition in massive collapse is akin to that in angioneurotic oedema of other tissues. The frequently abrupt onset and rapid clearing up of the condition, and the histological findings, go well with this theory.

If the true etiology of this interesting and important surgical complication is to be determined, it is essential that all cases coming to necropsy be carefully studied, recorded and reported.

While massive atelectasis of the lung in its usual clinical manifestation

is a benign complication, interesting rather than alarming, it is perfectly obvious that its benign nature depends on its being unilateral. Should the collapse involve the major portion of both lungs simultaneously, the inevitable result would of course be the immediate death of the patient. That this may take place is, we think, shown by the cases here reported.

As for the bearing of these cases on the etiology of the condition, there are several points to be emphasized. They give us a measure of the rapidity with which collapse may take place. In Case No. I, for instance, the chest signs were perfectly normal before operation. Throughout the operation the patient's breathing was quite natural. There was no indication at all of any respiratory disturbance. In fact she was in such good condition and so nearly awake that the anæsthetist had left her to start the anæsthesia on the next case, when she stopped breathing. This extreme rapidity of onset would in itself seem to rule out the theory of obstruction of the bronchi with subsequent absorption of the alveolar air as the etiological factor in this case.

Another point of interest is that the gross examination of the collapsed lungs gave no evidence of bronchial obstruction. There were no gross particles in the bronchi. Neither was there any of the muco-purulent secretion so strongly emphasized by Elliot, Dingley and Churchill as a probable etiological factor. The lung tissue was not œdematous in the ordinary sense of the word. The bronchioles and alveoli did not contain any excess of fluid above the normal.

Finally, these collapsed lungs present a striking histological picture. The uniform dilation and engorgement of the capillaries, arterioles and venules strongly suggest the probability of a vasomotor disturbance. At the same time the swollen, hydropic appearance of the epithelial cells lining the alveoli and bronchioles gives the impression of an interstitial œdema. The question naturally arises—may not this be a condition identical with or closely akin to angioneurotic œdema?

#### SUMMARY

1. Post-operative atelectasis, or massive collapse, is usually a benign, unilateral condition, occurring from a few hours to a few days after operation.
2. The collapse may, however, be bilateral and may occur at, or immediately after operation, and cause sudden death.
3. The extreme rapidity of onset of such cases tends to disprove the obstructive theory of the etiology of the condition.
4. There was no evidence of gross obstruction of the bronchi of the collapsed lungs at necropsy.
5. The histological appearance of these lungs strongly suggests that the cause of the atelectasis may be a vasomotor disturbance of reflex origin, possibly identical with or closely akin to angioneurotic œdema.
6. We hope the report of these cases will lead others carefully to record and report similar cases coming to necropsy. We urge that in cases of death during or after operation from obscure causes, where necropsy is not feasible,

post-mortem röntgenograms of the chest be taken to determine whether or not massive atelectasis is present.

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# EMBOLIC AND METASTATIC PHENOMENA IN PLEURAL AND PULMONARY INFECTIONS\*

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THE frequent association of brain abscess with intrathoracic suppuration, especially with bronchiectasis, has been noted by so many clinicians and pathologists that this complication is, no doubt, immediately suggested by the title of this paper. The startling manifestations of cerebral air embolism occurring during thoracic operations, the irrigation and dressing of thoracic wounds, or during simple exploratory or therapeutic chest aspiration are next uppermost in our thoughts.

Schorstein,<sup>1</sup> in his thesis on Abscess of the Brain in Association with Pulmonary Disease, reported 19 cases, of which 14 occurred in bronchiectasis. Of 69 instances collected and analyzed, 38 were of bronchiectasis and 15 of empyema, these two groups constituting more than three-fourths of the total. In 63 cases of bronchiectasis, cerebral abscess was the second most common cause of death. Concerning empyema as a cause of cerebral abscess, he noted that it had occurred when the pus in the pleural cavity had been undiscovered, when it had been merely aspirated, and when it had been evacuated by rib resection. It was usually in cases which had not healed long after operation that this grave sequel supervened. The danger of epileptiform attacks and sudden death during irrigation of empyema cavities was thought due to dislodgement of a thrombus from a pulmonary vein, but in no case had an embolus been found in the brain. In view of more recent knowledge we must assume that these were instances of air embolism.

Of Schorstein's own cases, 11 were single brain abscesses, 8 being in the left hemisphere. Of 33 solitary abscesses in a series of 51 collected cases, 25 occurred on the left side of the brain. The rarity of infarcts or abscesses elsewhere in the body was noted, but no figures on this point were given. Martius,<sup>2</sup> including three of his own, collected 22 cases of brain abscess of intrathoracic origin. Of 9 solitary abscesses, 7 were in the left hemisphere. In six cases, moreover, metastatic abscesses elsewhere in the body were discovered at autopsy, in the kidneys, the liver, the spleen, the heart muscle, and the ovary. Of five cases of empyema three probably had a coexisting pulmonary lesion to which the cerebral complication may well be ascribed (profuse purulent expectoration, 2; fetid pus in the empyema cavity, 1).

Lord<sup>3</sup> reports one case of cerebral abscess complicating empyema in which lung abscess could not be demonstrated at autopsy. In two others, foci of pulmonary suppuration were found.

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Schorstein pointed out the virulence of these cerebral complications, the patients dying in three to twenty-eight days after the first clinical manifestations. Up to the time of his paper, 1909, no case had recovered. Recently Barling<sup>4</sup> and Hurst<sup>5</sup> each report an operative recovery. In Barling's patient an abscess of the right occipital lobe was drained one month after the lung abscess was drained, the patient having entered the hospital with both lesions. Hurst's patient was known to be well thirteen years after an abscess of the right parietal lobe had been operated by Percy Sargent. This case was one of empyema following operation for acute appendicitis.

In considering embolic phenomena in pleural and pulmonary infections several questions presented upon which little definite information was to be found in the literature. Do emboli from this source lodge in parts other than the brain? Are such emboli always septic? If so, do they always result in suppurative metastatic lesions? Does the occurrence of peripheral embolic phenomena in a case of empyema always indicate an underlying suppurative focus in the lung? If not, how may such instances be explained?

For accurate answers to these questions I realize that careful and complete postmortem and bacteriological examinations are essential, but few facts seem available. During the years 1918 and 1919, when lung suppuration and empyema followed so frequently in the wake of the influenza pandemic, a number of unusual embolic and metastatic complications were noted which upon purely clinical grounds threw some light upon these queries. Subsequently additional cases were observed on the surgical services of the hospital. In the period 1918 to 1926 about 550 cases of empyema and 150 of pulmonary suppuration were admitted to the surgical wards. Brief reports of cases bearing upon the subject of this paper are appended together with comments upon them.

#### ASEPTIC CEREBRAL EMBOLISM

CASE I.—History No. 23-14, 1919, M. K., male, age fifteen years. Following bilateral influenzal pneumonia he developed a sterile left pleural effusion which later became purulent and was drained. During his convalescence a right empyema appeared. Intercostal incision for drainage was performed; the culture showed *Streptococcus hæmolyticus*. Two days thereafter a right hemiparesis and sensory aphasia were noted without convulsive phenomena. This lasted only a few days. Recovery was complete.

CASE II.—History No. 23-4, 1919, F. C., male, age sixteen years. Following influenzal pneumonia a left pleural effusion had been discovered and evacuated by Potain. A week later the temperature rose to 104° F. and sudden left hemiplegia occurred without loss of consciousness. On admission to the hospital two weeks later he presented a left hemiplegia and a left pyopneumothorax. The latter was drained by intercostal incision. Dakin's solution could not be used because of bronchial fistula. The chest healed. The paralysis of the left face and arm cleared up, but a spastic condition of the left lower extremity persisted. When seen four years later the boy still dragged the left leg.

CASE III.—History No. 24A-1, 1919, N. L., female, age three years. Two weeks before admission the child had pneumonia. A week later discoloration of the right foot and leg was noted by the parents. On admission she presented a dry gangrene of the right foot and lower two-thirds of the leg with a sharp line of demarcation. The



popliteal, femoral and external iliac arterial pulsations were not palpable on the right side. There was neither fever nor leucocytosis. Examination of the chest revealed dulness and broncho-vesicular breathing over the right upper lobe. X-ray examination showed an infiltration of the right upper lobe, an unresolved pneumonia. Five days after admission a complete right hemiparesis developed evidently due to cerebral embolism. Amputation was performed below the right knee, there was no bleeding from the stump, but the wound healed well. The hemiparesis disappeared entirely in two weeks. The amputated limb showed recent red thrombi in the veins, and proliferation of the media into the lumen of the arteries. No embolus was found in the arteries of the specimen, but it is to be remembered that no pulse was felt in the external iliac artery, the occlusion probably being higher up in the common iliac. Convalescence was uninterrupted.

*Comment.*—In none of these cases was any cardiac lesion demonstrable clinically to which these embolic phenomena might be traced. In the third case physical findings and X-ray examination demonstrated an unresolved pneumonia and it is reasonable to ascribe the embolic lesions to thrombi in the pulmonary veins of the diseased lung parenchyma. In the second case the cerebral embolism bore no relation to the therapeutic Potain aspiration, and took place before the operative intervention. The presence of air in the empyema cavity and of the bronchial fistula which became apparent after thoracotomy are sufficient evidence of a lesion in the lung tissue itself. It is possible that the embolus in this instance was of low grade infectivity and that a certain amount of brain tissue was irretrievably damaged without suppuration developing, as evidenced by the recovery of the patient with a residual spastic paralysis of the lower extremity. In the first patient transient hemiparesis occurred two days after intercostal incision for empyema. We know from experience in other fields of surgery that embolic phenomena (pulmonary embolism) occur usually ten to fourteen days after the surgical intervention, when thrombi in the operative wound are set free. From the other two cases we concluded that the embolus was traceable to the pulmonary lesion. It is therefore reasonable to assume that the same holds true in this instance, especially since the empyema was due to a pneumonic process in the lungs. If the embolus, moreover, were ascribed to a thrombus in a vessel of the operative wound we should have to assume a patent foramen ovale to account for its lodgement in the brain. From the rapidity with which the cerebral lesions cleared up it is likely that the embolus was small and aseptic.

The following additional cases of cerebral embolism were also observed: A man of sixty years operated for empyema following influenzal pneumonia was stricken with aphasia and right hemiplegia ten days after operation and died. A man of forty-five operated upon for bronchiectasis, a two-stage pneumotomy being performed, had a secondary hemorrhage requiring tamponade. Left hemiparesis occurred and he ceased two days thereafter. A man of thirty-six, previously operated for post-pneumonic lung abscess was readmitted for hæmoptysis. While his chest was being punctured with an exploratory needle, he became unconscious, right facial palsy and deviation of the eyes to the left were noted. He ceased soon thereafter, embolism of the left hemisphere being suspected. The brain was not obtained but the lung showed a residual small bron-

chial cavity surrounded by a hemorrhagic infarct which was probably the site of puncture by the needle. This may have been a case of cerebral air embolism. In two cases of sudden death five and eight days after operation for empyema, brain examinations were not obtained, but in one miliary lung abscesses were present with thrombosis in a pulmonary vein and in the other bronchiectasis communicating with the empyema cavity. In a man of thirty-nine with suspected lung abscess and empyema, right hemiparesis occurred eleven days after drainage of the empyema, but he made a rapid recovery therefrom.

#### EMBOLISM OF ARTERIES OF THE EXTREMITIES

CASE III.—Reported in detail, was one of embolic vascular occlusion of the right lower extremity in addition to hemiparesis due to cerebral embolism. Three additional cases of peripheral vascular occlusion are herewith briefly reported.

CASE IV.—History No. 23-58, 1918, H. B., male, age sixty-two years. The present illness began two months ago with fever, cough and expectoration, at times blood-tinged. Two quarts of fluid were removed from the right chest two weeks before admission. The man was poorly nourished and cyanotic, the fingers were clubbed. In the left axilla there were diminished breath sounds and coarse sticky râles. Posteriorly there was dullness from the apex to the angle of the left scapula and flatness from there to the base. The heart sounds were of poor quality, but no murmurs were discernible. X-ray examination of the chest showed infiltration of the left lung extending above the level of a collection of fluid in the pleural cavity. The left eighth rib was resected and an encapsulated empyema cavity with rigid walls, containing foul pus, was evacuated. Four days after operation there was sudden severe pain in the right upper extremity. The radial and brachial pulse disappeared, the axillary pulse still being palpable. The fingers and arm became limp, at first very pallid, later cyanotic. The patient ceased five hours after the vascular occlusion occurred, with symptoms suggesting cerebral embolism.

CASE V.—History No. 25-16, 1925. Reported through the courtesy of Dr. A. V. Moschcowitz. A. D., male, age eight years. Lobar pneumonia followed by pleural effusion. On the afternoon of admission the chest was aspirated and the doctor noted blanching of both lower extremities, mottled appearance of the skin and disappearance of the pulsation in both femoral arteries and the arteries distal to them. A diagnosis of saddle embolus of the aorta was made by Doctor Moschcowitz who operated as soon as possible, although the child's condition was poor. At laparotomy the aorta and both common iliac arteries pulsated. An embolus was removed from the left external iliac artery. This proved sterile on culture, and although containing numerous leucocytes showed no bacteria on section. Because of the patient's grave condition, the right iliac artery was not attacked. The patient ceased a few hours later.

CASE VI.—History No. 25-40, 1926. Reported through the courtesy of Dr. H. Neuhof. M. P., male, age forty-one years. Foul sputum for ten years, five to twenty ounces per day. Fever at times. General deterioration and loss of twenty pounds recently. There were physical signs and X-ray findings of pneumonic infiltration of the left lower lobe. The fingers were clubbed. At operation the lung was found adherent. The parenchyma was less infiltrated than expected and bled very little. Numerous dilated bronchi were opened, thick-walled and containing pasty material. No large cavity was encountered as had been hoped for. Six days after the exploration and establishment of bronchostomy there was sudden agonizing pain in the right lower extremity. Twenty minutes later a similar attack occurred in the left lower limb. The pain subsided in about an hour. On examination the right femoral pulse could be felt for one inch below Poupart's ligament, the limb was warm and the color good. The left femoral pulse and the left popliteal pulse in the upper part of the popliteal space were

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palpable, but the foot was cold, mottled and numb. The color subsequently improved. Oscillometric readings showed definite impairment of circulation in the legs, more marked on the left side. There was gradual improvement and on the third day both legs were warm, the left not as warm as the right. There was tenderness of the left popliteal artery below the point where the pulse could be faintly distinguished. Later this pulse became more distinct and the tenderness disappeared. There was complete functional recovery of the extremities.

*Comment.*—Four cases of embolism of the arteries of the extremities have been presented in patients suffering from various pulmonary lesions, namely, unresolved pneumonia, lobar pneumonia with pleural effusion, pneumonic infiltration with empyema, and pulmonary suppuration. In two cases there was evidence of cerebral embolism as well. The two last cases were probably instances of saddle emboli lodging at the bifurcation of the aorta, then breaking up to be carried into the more distal arteries of both lower extremities. Although two patients ceased, the others recovered without clinical indication of any infectious agents being carried in the emboli. In this group of cases as in the preceding group it seems reasonable to ascribe the emboli to thrombi in the pulmonary venous radicles. One cannot, of course, deny the possibility of trauma (aspiration or operation) as an exciting cause for their liberation into the greater circulation, but only when the embolic phenomena follow promptly upon the trauma is it reasonable to believe so.

### METASTATIC INFECTIONS

Thus far cases of aseptic embolism resulting in occlusion of relatively large peripheral arteries have been described. If perchance any of the emboli carried bacteria with them, they were either of very low virulence or the factors of local resistance were so great that suppuration did not supervene. In dealing with distant septic phenomena complicating pleural and pulmonary infections, a distinction may be made between septic embolism and metastatic infections. This distinction is one rather of degree than of kind. In septic embolism an infected thrombus is thrown off from a pulmonary venous radicle into the blood stream and lodging in a peripheral artery produces firstly, the effects of local vascular occlusion as do aseptic emboli, and secondly, suppuration in the infarcted tissue when the bacteria proliferate and invade this area and its surrounding tissues. In metastatic infections bacteria, either singly or in clumps, are thrown off into the circulation either directly or through the lymphatics and lodge in the capillary bed or smaller arterioles of distant parts where they produce suppuration. If the primary infection is in the zone of the greater systemic circulation these bacteria either lodge in the lungs, or may succeed in filtering through the pulmonary capillary bed and reënter the general circulation. They produce in the former instance miliary lung abscesses or in the latter, abscesses in the kidneys, spleen, bones and joints, or brain. If the primary infection is in the lung, however, such bacterial emboli pass from the pulmonary veins to the left auricle and thence

directly into the general circulation. The resulting lesions are known as metastatic abscesses or infections.

The following are cases of such peripheral metastatic suppurative lesions originating from a primary intrathoracic focus.

CASE VII.—History No. 23-73, 1918, S. S., male, age thirty-seven years. Pain in right chest fourteen days. Pain in right knee four days. Dyspnoëic, cyanotic. Herpes labialis. Signs of consolidation of left upper lobe, with fluid at the base. The right knee was red, swollen and contained fluid. A large empyema was drained by intercostal incision, culture streptococcus hæmolyticus. The right knee was aspirated and irrigated, culture streptococcus hæmolyticus. Ante-operative blood culture, sterile. Ten days after operation hemorrhage from the empyema cavity and profuse hæmoptysis caused death. There was no autopsy.

CASE VIII.—History No. 25-21, 1919, D. L., female, age two years. Cough, dyspnoëa, and blood-streaked sputum for three weeks. Bronchoscopy showed no foreign body but the bronchus to the left lower lobe was dilated. June 6, 1919, operation for left empyema revealed a multilocular lung abscess of the lower lobe which was drained. June 20, 1919, swelling of right thigh which upon operation proved to be an epiphysitis of the upper end of the femur, culture Staphylococcus aureus. There was eventual destruction of the upper part of the femur and disappearance of the head of the bone. With immobilization after osteotomy healing took place. Subsequent X-ray of chest showed numerous thin-walled cavities occupying the entire left lung.

CASE IX.—History No. 23-78, 1919, W. E., male, age four and one-half years. A patient operated elsewhere for post-pneumonic empyema four weeks before admission had a discharging sinus of the left chest. The ramifying sinus was laid open and packed. Two weeks later he was readmitted for fever and swelling of the right thigh. X-ray showed periostitis of the upper half of the femur. At operation a perforated epiphysitis of the upper end of the femur was found. Later the lower epiphysis became involved. Culture, staphylococcus aureus. Although blood culture was negative, a pyarthrosis of the ankle developed, and he died.

CASE X.—History No. 23-79, 1919, W. L., male, age fifty-nine years. Operated for left empyema, constant discharge from wound ever since. Six weeks ago fever and chills followed by headache which has been getting progressively worse, and pain in the right knee. Night sweats, loss of weight. Soft, tender, red swelling of the forehead with œdema of both eyelids. X-ray of chest showed only density of the left apex. The skull showed a destructive lesion of the frontal bone on the left side.

Probing the chest sinus yielded two ounces of thick dark red pus. Incision of the scalp abscess revealed osteomyelitis of the skull. Under observation the destruction of the skull bones progressed rapidly over the vault. The right femur was explored but no pus found. Blood and spinal fluid Wassermann negative. Antiluetic treatment had no effect. He died two months after admission. No autopsy was obtained.

CASE XI.—History No. 25-21, 1920, G. S., female, age forty-two years. Sore throat and chills followed by pneumonia. X-ray showed unresolved pneumonia of right lung. While under treatment a suppurative arthritis of the knee developed which required extensive incisions for drainage. Culture, streptococcus hæmolyticus. She recovered with an ankylosis.

CASE XII.—History No. 23-50, 1921, F. S., male, age four years nine months. Operated for left empyema, post-pneumonic, culture streptococcus hæmolyticus. Three days later right epididymo-orchitis, then left. The left subsided, the right suppurated and was incised, culture streptococcus hæmolyticus. Recovery.

CASE XIII.—History No. 25-23, 1924, L. L., female, age three and one-half years. Pneumonia of right lower lobe followed by empyema. Culture of latter upon operation

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showed pneumococcus and streptococcus hæmolyticus. A week later pyarthrosis of left hip which was drained and yielded the same organisms on culture.

CASE XIV.—History No. 23-25, 1925, R. G., female, age twenty years. Bronchiectasis since infancy. Two weeks ago chill and fever followed by swelling in right gluteal region. A large deep foul-smelling abscess was incised, which on aërobic culture yielded no growth. Anaërobic cultures were not made. Blood culture was negative. At post-mortem bronchiectasis of right and left lower lobes was found with purulent bronchopneumonia. No lesions were observed in the pulmonary veins.

CASE XV.—History No. 25-35, 1926, A. Z., female, age twenty-nine years. This patient had a bronchostomy performed for abscess of the right upper lobe. A month later she had chills and fever and developed painful swelling of the left knee, then the right knee, the right elbow and other smaller joints. Blood cultures yielded streptococci. About three weeks later there was a hemorrhage from the bronchial fistulous tract and she died. At post-mortem an undrained abscess of the right upper lobe was found. The pulmonary vessels were negative.

*Comment.*—These nine cases of intrathoracic infection varied considerably in character including pneumonitis, empyema both recent and old, lung abscess, and bronchiectasis. The microörganisms found in the metastatic lesions were the ordinary pyogenic ones, streptococci and staphylococci. In only one case (No. 14) did the metastatic lesion assume the foul character of anaërobic infection which is so commonly present in the lung suppurations. The sites of predilection for these organisms thrown off into the general circulation were the joints, the epiphyses and the flat bones. In only one instance (Case No. 15) was a bacteriæmia demonstrated. No lesions of the pulmonary veins were found in those cases which came to autopsy, a finding which conforms to the conception of metastatic infection.

### BRAIN ABSCESS

When the subject of brain abscess secondary to pleural and pulmonary infections is considered the distinction between embolic and metastatic cerebral lesions is somewhat difficult to maintain. I have already shown that aseptic cerebral vascular occlusion may occur in both suppurative and non-suppurative pulmonary inflammations, probably due to thrombosis in pulmonary venous radicles. Further post-mortem evidence of this mechanism will be given subsequently. It has also been stated that bacteria entering the blood stream from the lung or from infections in the field of the greater circulation can reach the brain without any demonstrable lesion of the veins in the vicinity of the primary focus. On the other hand, thrombosis in the pulmonary veins draining a suppurating area of the lung may be of the infective variety, *i.e.*, a purulent thrombophlebitis. Fragments of such a thrombus breaking off and lodging in an artery of the brain would first cause vascular occlusion with its resulting clinical phenomena, and then cause suppuration of the infarcted area. If, however, a few bacteria or a clump of bacteria enter the brain and gain a foothold there, an insidious onset of cerebral symptoms would occur as the resulting area of suppuration would develop

more slowly and gradually. This would be so especially if a shower of organisms entered the brain and set up a diffuse encephalitic process.

The clinical manifestations of cerebral suppuration secondary to intrathoracic disease have been so well described and are so well known that detailed histories of the cases observed on the wards of the Mount Sinai Hospital will be omitted. Of seven surgical cases suspected only three were in condition for exploratory craniotomy. In two the abscess was found. No case recovered. One clinical fact is of importance, namely that, in general, embolic phenomena occur especially in those patients who have hæmoptysis or who have post-operative hemorrhage from the lung after pneumotomy for drainage.

#### POST-MORTEM OBSERVATIONS

In an effort to substantiate the statements made as to the pathogenesis of the embolic and metastatic phenomena observed in pleural and pulmonary infections, I have reviewed the post-mortem records of the Mount Sinai Hospital since 1918. Complete examination including the brain was procured in 18 cases, of which 15 were cases of lung suppuration. There was one case of lobar pneumonia with purulent encephalitis, one of bronchopneumonia and empyema with no demonstrable abscess complicated by abscesses of the kidney, one of bronchopneumonia and empyema complicated by meningitis. In these three cases no lesion of the pulmonary veins was demonstrable, the complications probably being in the nature of metastatic infection. In the fifteen cases of pulmonary suppuration the following complications were noted: cerebral air embolism, 1; brain abscess, 6, of which 3 were single and 3 multiple; infarct of kidney, 1; abscesses of both kidneys, 1; gluteal abscess, 1; suppuration of sacro-iliac synchondrosis, 1. In four of the cases lesions of the pulmonary veins in the vicinity of the suppuration were demonstrated, recent and organizing thrombi, phlebitis, arteriovenous aneurism. Each of these four patients presented embolic lesions, either in the brain, the kidneys, or the bones (sacro-iliac synchondrosis). Thus of 18 cases examined, 15 showed lesions in distant organs. In two other cases of lung suppuration only the brain was obtained and in each a single abscess of the occipital lobe was found with rupture into the ventricle causing sudden death.

In 43 cases complete examination except for the brain was obtained. The following secondary lesions were noted: infarction of spleen, 2; abscesses of kidney, 2; multiple joint infection, 1; peritonitis, 1. In two cases a cerebral lesion was suspected but the brain was not obtained. In four cases lesions of the pulmonary vessels were demonstrated; purulent thrombophlebitis, 2; eroded veins in wall of abscess, 1; thrombosis of small artery with infarction of lung at site of exploratory puncture (sudden death), 1.

In 42 cases examination of the thoracic organs alone was obtained. In four of these thrombosis in pulmonary veins radicles was found.

Thus, in 98 cases pulmonary vascular lesions which did or could produce

## EMBOLIC AND METASTATIC PLEURAL AND PULMONARY INFECTIONS

embolic phenomena, were observed in 12 instances. It seems probable that if more detailed examination with reference to this point were made, the incidence would be still greater.

### AIR EMBOLISM

The occurrence of sudden collapse and possibly death upon exploratory puncture of the chest or lung was long ascribed to pleural shock. Epileptiform attacks and death during irrigation of empyema cavities was thought due to the dislodgement of a thrombus and its lodgement in the brain. More recent study of these cases, however, for example by Naegeli of Garre's Clinic,<sup>6</sup> ascribes these phenomena to cerebral air embolism brought about by injury of a pulmonary venous radicle by the exploring needle or the scalpel. Air from the exterior, from the pleural cavity or from a pulmonary bronchus or cavity is sucked into the veins, enters the left heart and thence passes to the brain. Examination of the fundi may show air bubbles in the retinal vessels. Convulsions followed by unconsciousness and then amaurosis are characteristic of this syndrome. Reyer and Kohl<sup>7</sup> of the U. S. Army have reported ten cases complicating therapeutic pneumothorax due probably to transfixation of anastomotic vessels in pleural adhesions. By way of prophylaxis a large calibred blunt needle is recommended in refilling the chest, keeping the head of the patient lowered during and after the procedure.

In six cases of the series which I reviewed cerebral air embolism was suspected, but only one in which post-mortem examination confirmed the diagnosis is herewith reported.

CASE XVI.—History No. 25-36, 1926, R. L., female, age twenty-one years. Post-tonsillectomy lung abscess. Three years ago a two-stage pneumotomy was performed. Bronchial fistula persisted. At times there was hæmoptysis and bleeding from the fistulous tract. Patient admitted for severe bleeding and hæmoptysis. The tract was exposed and explored for source of hemorrhage. An artery in the wall of the pulmonary tract was ligated and divided. Ten minutes after operation was begun the patient died suddenly. At the post-mortem examination air was demonstrated in the left ventricle and in the vessels of the brain.

### CONCLUSIONS

The peripheral complications of pleural and pulmonary infections may be classified as embolic and metastatic.

The embolic complications may be aseptic or septic. They may occur in both non-suppurative and suppurative lung infections, but chiefly in the latter. They are referable to thrombotic and phlebitic lesions of the pulmonary veins. They may involve not only the brain, but the arteries of the extremities. They may also involve the spleen and the kidneys.

In cases of empyema the embolic complications should be referred to the underlying pulmonary disease and not to the empyema *per se*. Of 69 cases of empyema coming to autopsy, inflammatory lesions were present in the

lungs in every instance. Of these 47, more than two-thirds, showed miliary or large abscesses, bronchiectasis, gangrene, etc.

Metastatic infections of the soft parts, joints, epiphysis and flat bones occur in pleural and pulmonary infections. They are more frequent in cases with empyema, bronchiectasis and lung abscess than in simple pneumonitis.

The clinical observation of the association of embolic phenomena with hæmoptysis and post-operative hemorrhage is in accordance with the post-mortem evidence of vascular lesions in the lung parenchymia as the underlying causative factor of such phenomena.

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# SUBCUTANEOUS RUPTURE OF THE LIVER\*

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INJURY of the liver as the result of non-penetrating violence, *i.e.*, sub-  
parietal rupture is rare enough in civil practice to justify reporting eleven  
additional cases. For the privilege of adding ten of these, I am indebted to my  
colleagues of the German Evangelical, Englewood, St. Bernard's, South Shore  
and Wesley Memorial Hospitals. The eleventh case occurred in the author's  
practice. Before reviewing our pres-  
ent information as to the mechanism,  
diagnosis and treatment of such  
injuries, a summary of the chief  
clinical features of the eleven cases  
will be given.

CASE I (Dr. J. F. Hultgen).—Boy of  
thirteen run over by wagon. Marked  
shock, thirst, pallor and dulness all over  
abdomen. Slight rigidity. At operation  
large amount of blood free in peritoneal  
cavity. Right lobe of liver torn off (Fig.  
1) also rupture of spleen. Died without  
being able to check bleeding.

CASE II (Doctors Rickfort and Wein-  
berger).—Boy of eight crushed by rear  
axle of automobile. When seen thirty-  
four hours after injury, pulse 100, temperature 101, vomiting of bile-stained fluid, dulness  
on right side of abdomen and flank. At operation hemorrhage from tear in right lobe  
of liver apparently controlled by packing, but died twelve hours later. Autopsy revealed  
a tear (Fig. 2) in extraperitoneal surface of right lobe of liver.

*Comment.*—Symptoms of visceral (liver) rupture did not develop until thirty-four  
hours after injury. Drainage and transpleural packing might have been successful.

CASE III (Dr. W. R. Abbott).—Man of twenty-three crushed between two freight  
cars. Extreme shock, marked rigidity; radiography revealed fracture of pelvis. Apparent  
recovery after conservative treatment. Suddenly on seventeenth day enormous distention  
and also dulness across upper abdomen developed. At operation large amount dark liquid  
blood found; also extensive tear (Fig. 3) of both lobes and gall-bladder. Liver wound  
packed. Recovery.

CASE IV (Dr. A. J. Graham).—Boy of nine run over by automobile, wheel passing  
over right side of abdomen. Severe shock, right rectus rigidity for two hours, then sudden  
rise of pulse rate and death two hours later. At autopsy complete separation (Fig. 4)  
of right and left lobes of liver. Extensive retroperitoneal hemorrhage. Operation refused  
shortly after accident.

CASE V (Dr. D. E. Meany).—Man of twenty-four fell across rail. Treated for

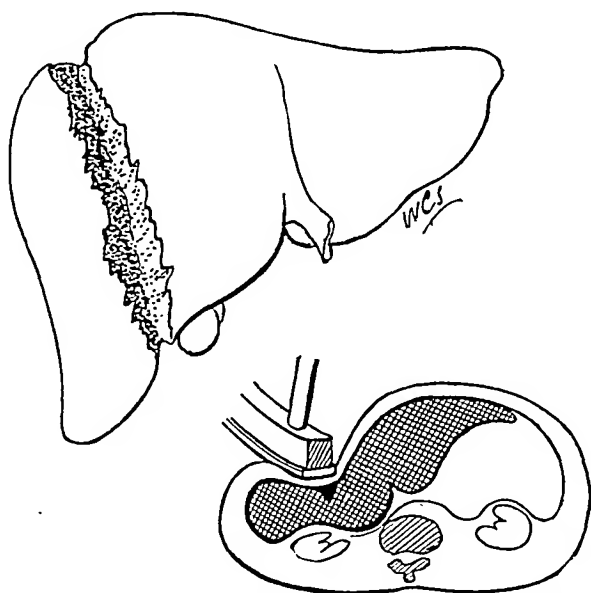


FIG. 1.—The wheel of a vehicle split the right lobe  
down to the posterior capsule. Fatal hemorrhage.

\* Read before the Englewood Branch, Chicago Medical Society, November 2, 1926.

fracture of ribs. Symptoms of paralytic ileus on following day. On third day rapid pulse, dulness, rigidity and abdominal pain. Operation (third day): Long tear (Fig. 5) in right lobe. Recovery complicated by empyema requiring resection of rib.

CASE VI (Dr. L. H. Stern).—Male adult fell from scaffolding fifty feet high on abdomen. When seen next day, sixteen hours later, pulse rapid, pallor, right rectus rigidity. At operation much free blood with detached portion of right lobe lying free (Fig. 6) in peritoneal cavity. Hemorrhage controlled by mattress sutures. Recovery.

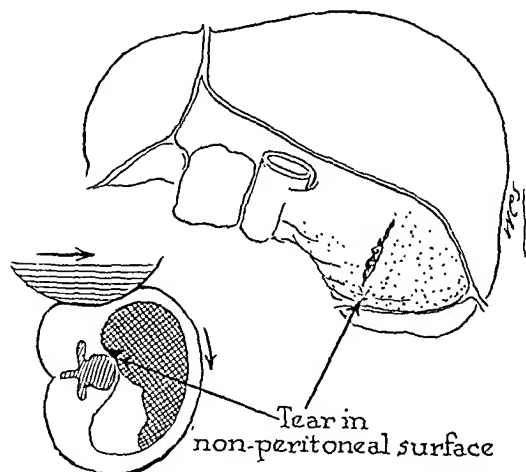


FIG. 2.—Boy rolled between differential of an automobile and the ground, causing a rupture of the liver on the non-peritoneal surface, and perinephritic hemorrhage.

five hours after accident found (Fig. 8) deep right lobe tear. Hemorrhage controlled by packing. Death ten days later after high fever for last two days.

CASE IX (Dr. J. B. Haerberlin).—Boy of thirteen run over by heavy truck. Shock, pallor, pulse slow and weak. Dulness over entire abdominal cavity. At operation three hours after accident three fragments of liver tissue found detached (Fig. 9), also extensive tear of right lobe, which was packed. Recovery.

CASE X (Dr. W. G. Epstein).—Girl of ten struck over dorso-lumbar region by automobile. Marked abdominal rigidity, pain, and evidences of free fluid. At operation three hours after accident two-inch tear in inferior surface (Fig. 10) of left lobe found and packed. Recovery.

CASE XI (Dr. A. G. Scherer).—Fell across steel platform. When examined fifteen hours later, pulse 130, very little rigidity, but liver dulness extended to umbilicus. Died thirty hours after injury. No operation performed. At autopsy liver showed tear on under surface of right lobe (Fig. 11) with much free blood and pus in peritoneal cavity.

Of these eleven cases of subcutaneous rupture of the liver herein reported four (Nos. I, II, V, and XI) died as the result of delayed or faulty diagnosis or both. Some of these fatalities were due to incomplete surgical examination upon admission. Three of these cases were sent home only to be brought back to the hospital after the abdominal symptoms had become more pronounced.

CASE VII (Dr. J. A. Shacter).—Woman of thirty-one struck by wheel of an auto across abdomen. Pallor, abdominal rigidity and increased liver dulness. At operation one hour later deep rupture (Fig. 7) on anterior surface of right lobe closed by suture. Recovery.

CASE VIII (Drs. J. T. and E. J. Meyer).—Man of twenty-eight struck by iron band over right upper quadrant. Tenderness and rigidity over this portion of abdomen, also pallor, thirst, and rapid rise of pulse rate (96 only). At operation

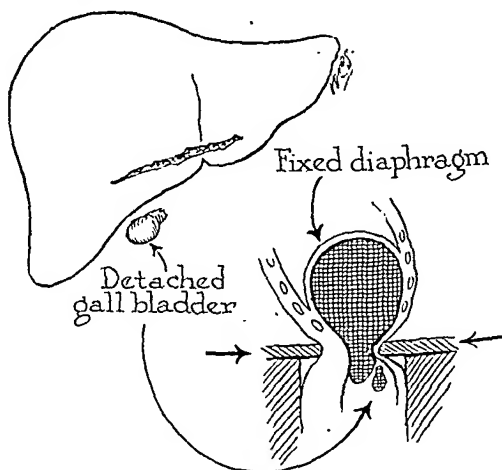


FIG. 3.—Crushed between freight cars. Rupture of the liver and gall-bladder. Fractured pelvis.

## SUBCUTANEOUS RUPTURE OF THE LIVER

Injury to the liver follows generally certain mechanisms and is for the most part of two varieties: (1) A certain circumscribed striking force, as falls, horse-kicks, or explosions (as Cases Nos. V, VIII and XI); or (2) the forcible approximation of two rigid planes, one behind the spinal column and fixing it, the other plane in front forcing the liver against the forward curving lumbar vertebræ (as in Cases Nos. I, II, III, IV and IX). In Case No. IV such a mechanism caused a sagittal rupture between the two lobes by flattening them over the vertebral column just as a saddle is flattened over the wethers of a horse.

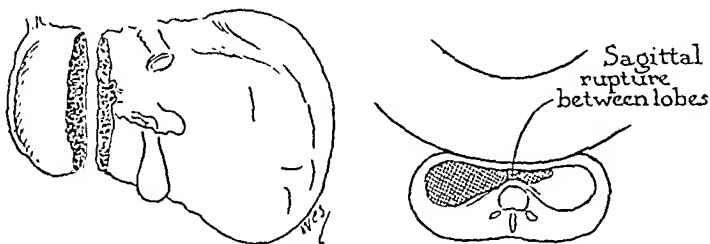


FIG. 4.—Automobile passed over abdomen, causing sagittal rupture. Hæmatoma in omental bursa and retroperitoneally.

### SYMPTOMS AND DIAGNOSIS

*A. General Shock Symptoms.*—The cause of the symptoms of shock must be ascertained whether it is due to the primary single impact, or is being produced by continuous sensory nerve irritation due to the flooding of the peritoneal cavity by blood, bile or visceral contents.

In liver lesions the pulse usually rapid, small and sometimes slow is, following the sudden fall of blood-pressure, accelerated to 140–160. This sudden circulatory failure, actually observed in Case No. IV, occurs sooner and oftener in internal hemorrhage than in visceral perforation.

*B. Local Abdominal Symptoms.*—The diagnosis of abdominal injuries is based upon three findings, (1) dulness due to hemorrhage, (2) tympanites, and (3) involuntary muscular rigidity.

1. *Abnormal Dulness.*—This is positive proof of liver injury. It appears early, extends laterally and above the symphysis. Bulging in the cul-de-sac of Douglas is present only if the patient has been in the upright position.

If the blood escapes from the torn liver in small amounts it clots near

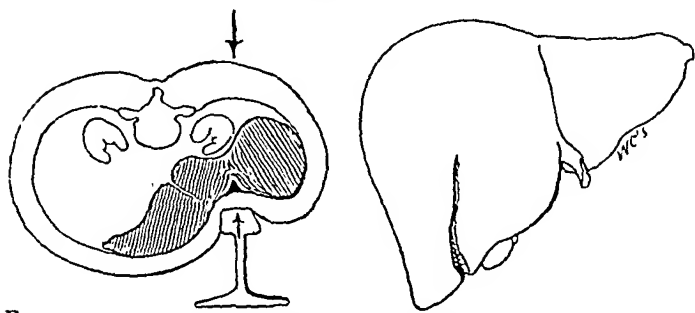


FIG. 5.—Fell upon railroad track, striking right costal border upon rail. Walked a mile. Empyema.

the point of traumatization as in Case No. IV, where clots formed posteriorly between the separated lobes and floated the intestines up, causing tympany instead of dulness. In many instances the dulness is small, questionable, not present until

four to six hours after the trauma, and often not until the next day (Cases II, V, VI and XI). Blood in the abdomen is much less mobile than fluid in ascites (Fothermeyer's sign). Shifting dulness is delayed several minutes.

2. *Tympanites.*—Just what causes a bowel to lose its motor activity,

dilate and become filled with gas is not as yet fully understood. Either the vagus is paralyzed, or irritation of the sympathetic produces an excessive inhibition of peristalsis. (We can understand how powerful peristaltic waves obstructed at the injured point of the intestine would exhaust the muscles

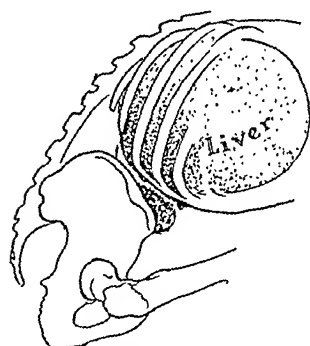


FIG. 6.—Fall of fifty feet from scaffold. Fragment from tip of right lobe found free in cavity.

of the bowel above trying to bridge over the gap—and produce a paralyzed and tympanitic intestine). Pressure or injury to the retro-peritoneal plexuses would reflexly influence the play of nerve impulses to and from the bowel, and explain the enormous tympanites mentioned by Thole as produced

by crushing the pancreas or liver against the vertebral column, or by pressure of retroperitoneal hæmatomas.

*Disappearance of Liver Dulness.*—The distended loops of intestine displace the liver upward, diminishing or obliterating the liver dulness. This disappearance of liver dulness is often given as proof of an abdominal lesion and wrongly so. In intestinal perforation large free pneumoperitoneum is rare; and there must have been a sufficiently large quantity of gas expelled from the full stomach or intestine into the peritoneal cavity.

Therefore, post-traumatic diminution of liver dulness is not of itself a proof of an intra-abdominal injury, but if tympany and post-traumatic diminution of liver dulness is accompanied by an increasing abnormal dulness, an abdominal lesion is almost certain to be present.

3. *Involuntary Rigidity.*—In liver injuries the abdominal muscles become immediately tense, often locally so, especially in the right upper quadrant of the abdominal wall. Involuntary muscular rigidity is caused by the irritation of the sensory ends of the intercostal and lumbosacral nerves in any portion of their course (Fig. 12). It occurs when the parietal peritoneum is irritated, and is therefore absent only when the pathology is not in contact with the walls of the abdominal cavity.

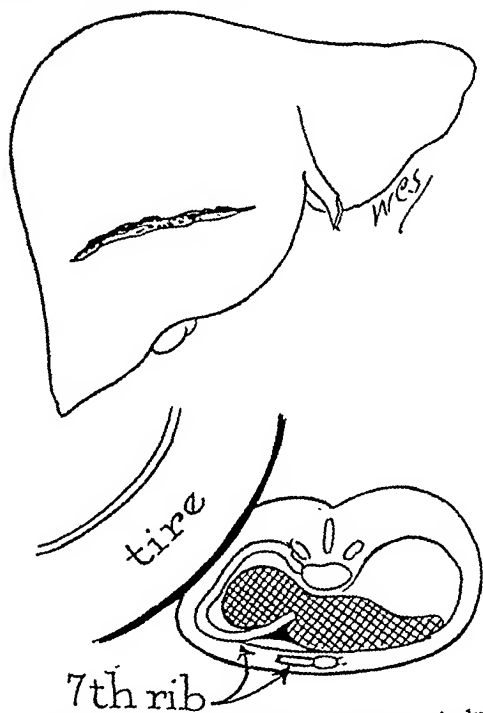


FIG. 7.—Automobile wheel passing over body fractured the seventh rib which lacerated the right lobe of the liver.

## SUBCUTANEOUS RUPTURE OF THE LIVER

We observe abdominal rigidity during pleurisy, pneumonia, lung injuries, or fracture of the ribs through direct irritation of the intercostal nerves as a reflex, or as irritation of the posterior roots of the spinal nerves in fracture of the spine, or in retroperitoneal hemorrhage.

*Differentiation Between Chest and Abdominal Injuries.*—It is difficult to diagnose a liver lesion when the thorax is also traumatized especially on both sides. Thoracic lesions obscure the abdominal symptoms by restricting respiration as a result of irritation and reflex immobilization of the diaphragm, and by producing reflex tenderness and rigidity in the upper abdomen. Noetzel thought that in thoracic lesions pain on pressure and rigidity could not possibly reach farther down than the umbilicus. He refers to a gunshot wound of the left lung in which persistent board-like rigidity and excessive tenderness induced the surgeon to laparotomize the patient without finding any lesion of either diaphragm or abdominal viscera.

Differentiation between chest and abdominal trauma or disease is well illustrated by the following simple case:

V. S., age eight, was thrown by an automobile, her chest striking a four-inch high curbstone at the level of the fourth rib. Hæmatemesis, pallor, shock, pulse 110, and abdominal rigidity. The X-ray revealed fracture of the fourth rib, one inch from the sternum, and of the tenth rib one-half inch from the spinal column.

Because of the hæmatemesis and rigidity of the right rectus she was watched for an abdominal lesion. The pulse went up to 128, but soon dropped to 108. After watching the patient for three hours the initial shock disappeared and color came to the lips. The abdomen retracted to restrict respiration over the broken ribs, and so the girl's appearance indicated a clearing of the uninjured from the injured cavity as a ship clears a pier in shoving off.

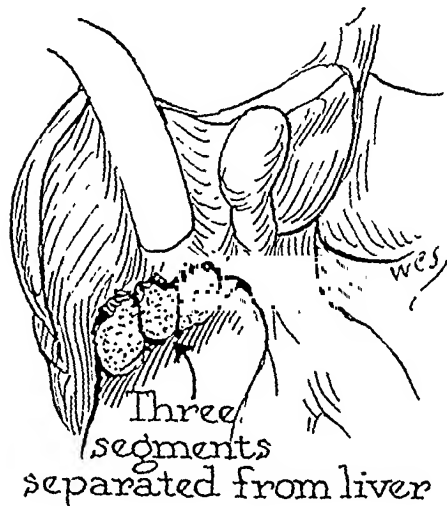


FIG. 9.—The wheel of a two-ton truck passed diagonally over the abdomen, crushing the right lobe of the liver, and injuring the left kidney and bladder.

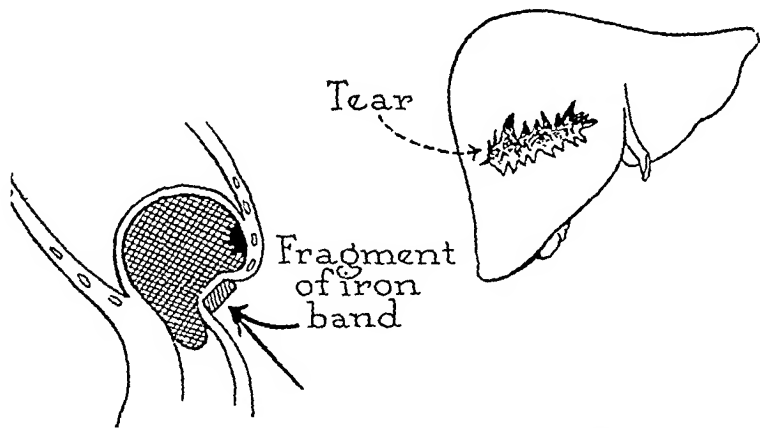


FIG. 8.—A piece of iron band with explosive force struck the right costal border which with the fixed diaphragm composed two polar forces causing an equatorial rupture of the liver capsule.

### DIFFERENTIAL DIAGNOSIS OF INTERNAL HEMORRHAGE

(a) *From Perforation.*—Rupture of a full stomach or urinary bladder also shows dulness. This dulness increases more rapidly with internal hemorrhage than with peritonitis, but sudden flooding of the peritoneal cavity with stomach contents produces a simultaneous peritonitis with its signs (pain, temperature, vomiting, rigidity) so abruptly

that in most cases we can make a diagnosis of peritonitis before one of hemorrhage or rupture. Such a perforation of the stomach can be differentiated from hemorrhage by the rapid disappearance of liver dulness which is due to

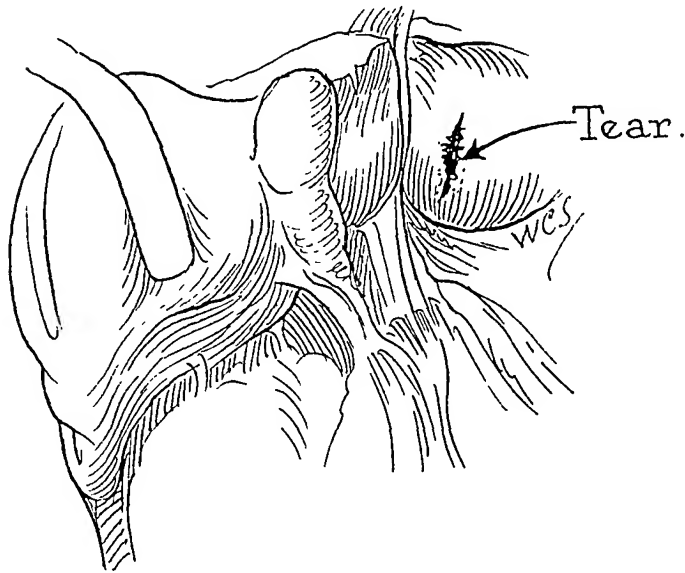


FIG. 10.—Speeding automobile struck the patient in the back, causing an over-extension of the spinal column, and tearing the left lobe of the liver, producing hemorrhage.

pneumoperitoneum. Such disappearance requires several hours in hemorrhage.

In general, we can diagnose internal hemorrhage earlier than visceral perforation because of the characteristic local symptoms of abdominal dulness and the muscular rigidity due to hemorrhage, and because the general symptoms of acute anemia appear earlier than the local symptoms of a peritonitis.

(b) *From Peritonitis.*—In this instance it takes time for enough exudate to collect to produce dulness (thirty-one hours in Case No. XI), therefore it is too late in appearing to be of any diagnostic value.

Late disappearance of liver dulness or late crowding out of the same is a classical symptom of advanced peritonitis. It is produced by a paralyzed and tympanitic intestine, and rotates the liver upon its edge by pressure from below.

*The Dangers of a Liver Rupture.*—Liver hemorrhage is dangerous because (a) the blood-pressure in the portal system is low, the bleeding marked and continuous, and the thin-walled, hepatic veins without any valves tear easily and gape without retracting or contracting.

(b) Because the liver blood mixed with bile coagulates very slowly.

(c) The liver vessels have only a very few vasomotor fibres in comparison with the kidney, spleen and intestinal vessels.

(d) Because the respiratory movements of the diaphragm and abdominal wall produce a continuous blood-pressure variation.

For these reasons spontaneous hæmostasis of a liver wound is very rare.

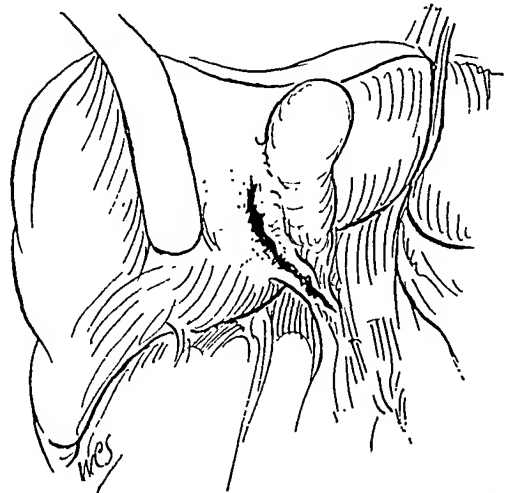


FIG. 11.—Fell six feet bending body to left sharply over a steel platform. The tear caused in the right liver lobe resulted in peritonitis.

## SUBCUTANEOUS RUPTURE OF THE LIVER

In secondary hemorrhage from liver injury the blood-pressure is raised by some violent act as coughing, or getting up. The occluding thrombus is loosened, the tear enlarged and the secondary hemorrhage begins. It may occur from the third to the fortieth or fiftieth day after injury and sudden death result.

An intra-abdominal hemorrhage can lead by either mechanical or chemical processes to reflex ileus, acute gastric dilatation and cardiac paralysis without infection and cause death, not by hemorrhage but by its reflex effects. Later on, some of the collections of blood may suppurate and cause a fulminant peritonitis (Case XI).

### OPERATIVE TREATMENT OF LIVER INJURIES

If initial shock continues in liver injuries one should operate within three hours. It is dangerous to wait for dulness to form. The mortality of abdominal lesions increases with every hour.

*Technic.*—(a) *Preparation:* During the observation period and as long as the diagnosis is in doubt let the patient have no morphin, nor anything by mouth.

(b) *Incisions:* The median epigastric incision (Fig. 13) is the simplest. It is far enough away from the hilus to permit delivery of a part of the liver outside of the abdominal cavity. It may be closed in three layers by resorting to Stiles' method of splitting the rectus fascia to secure tissues for suturing in three layers.

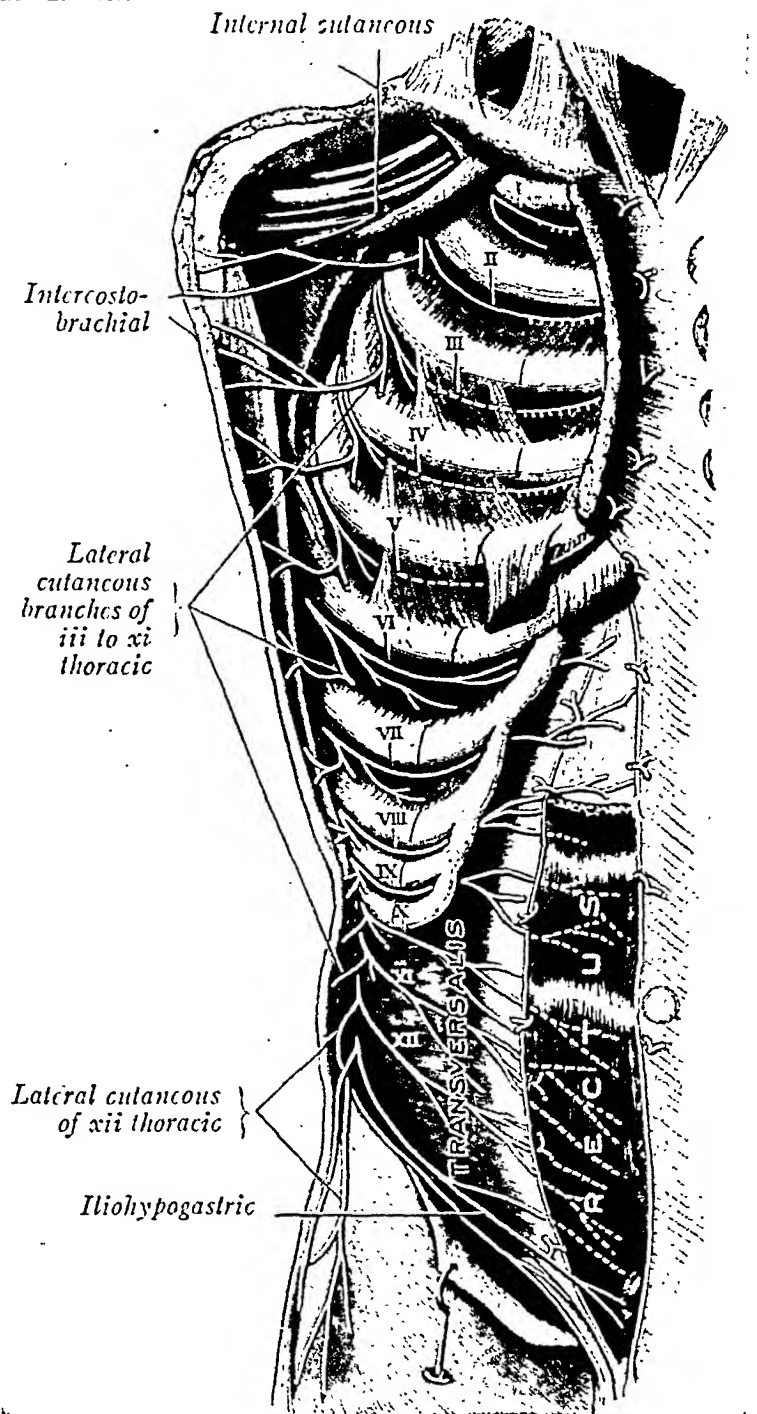


FIG. 12.—Drawing showing the intercostal nerves, the superficial muscles having been removed, to aid in showing the predominance of rigidity of chest or abdomen in disease or injury. (From Lewis' 20th Edition, *Gray's Anatomy*.)

Kausch's incision (Fig. 13) is the best flap method to use in conjunction with the median epigastric.

(c) *Displacing the Liver* (Fig. 14): Judd called attention to the fact that only by keeping the incision near the median line can the liver be rotated upward by bringing the free edge of the right lobe out of the abdominal wound, and thus bring the gall-bladder and gall-ducts into better view. This rotation occurs with the hilus as the centre and with a radius reaching to the tip of the right lobe six to eight inches away. The tension on the liga-

ments bring down the diaphragm which is partially fixed, making the respiratory excursions rapid and shallow. This manœuvre will succeed only in flexible livers, but it gives an excellent view of the under surface of the lobes.

(d) *The Transpleural Field.*

—In stab wounds of the lower thorax the Italian and Russian surgeons use transpleural incisions very successfully. Neither the median epigastric nor the Kausch incision are adequate to take care of a wound of the dome. It is always safer to begin with the median epigastric incision in order to orient one's self, to palpate the rupture, and then to make the transpleural incision especially if the wound is posterior and lateral.

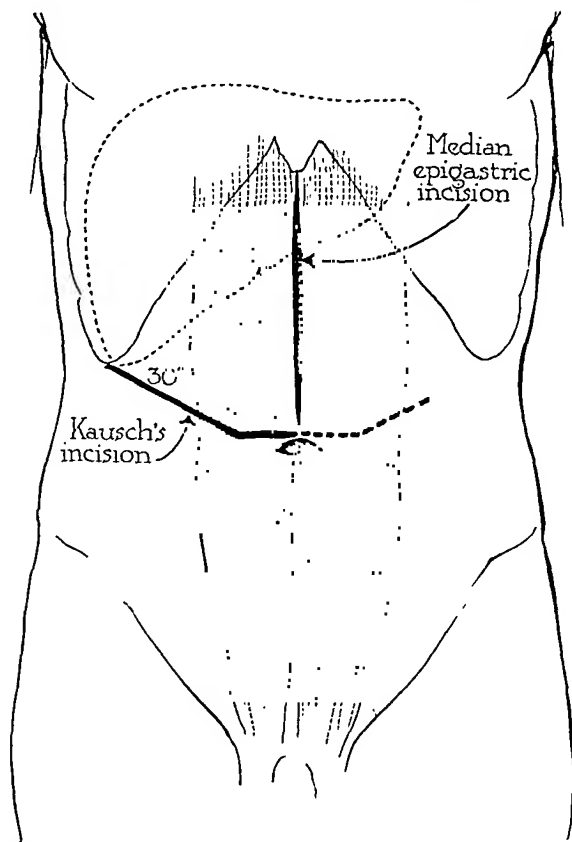


FIG. 13.—The median epigastric and Kausch's diagonal flap incisions.

After the abdomen is opened the assistant by making bilateral pressure can control the hemorrhage in sagittal rupture. The hepato-duodenal ligament may also be compressed while temporary packing is inserted and renewed while the suturing is done, working slowly and synchronously with the respiratory excursions. In the more serious cases in the search for the source of a profuse intra-abdominal hemorrhage the work is facilitated, according to Thole,<sup>1</sup> by compression of the aorta immediately below the diaphragm by means of Dahlgren's aortic compressor. After the course of the hemorrhage has been found the hepato-duodenal ligament is compressed with a rubber-covered Murphy intestinal clamp, while the aortic compression is maintained, and is safely left *in situ* one-half hour or until the liver injury has been taken care of.

There are only two procedures of definite hæmostasis, packing and suture.

*Packing or Tamponade.*—*Fixing the Liver:* It is best to fix the liver by



## SUBCUTANEOUS RUPTURE OF THE LIVER

packing it away from the diaphragm, so that the gauze will take up the movement of the respiratory excursion and leave the liver packed down low and in good view. Packing is then placed between the liver and the costal border to remove from the liver any lateral movement from the ribs. Tamponade is



FIG. 14.—Displacing the liver for the exposure of its inferior surface consists of three movements, *a* direct downward traction, *b* rotation anteriorly and *c* rotation at right angles to the right costal border.

then applied directly to the liver wound firmly and with no haphazard methods. The danger of all tight packing is ileus of the bowel from obstructing the portal circulation and splanchnic nerve impulses in the hepato-duodenal ligament.

*Suture*.—This is the ideal method since it exuviates the bile to the lumen

of the bowel, its normal course—a very probable reason why subphrenic abscesses are more frequent with packing than with suture.

A special needle has been devised (Fig. 15) to use in the gloved hand to secure a firm grasp in order to sew securely against active hemorrhage, no needle-holder being necessary. Sutured liver wounds are very painful due to the presence of many sensory nerves in Glisson's capsule.

*Advantages of Suture.*—(1) Because it restores to a certain extent the normal conditions of the liver.

(2) Since we can close the belly by primary suture, healing takes place more rapidly and the danger of herniation and secondary infection is practically nil.

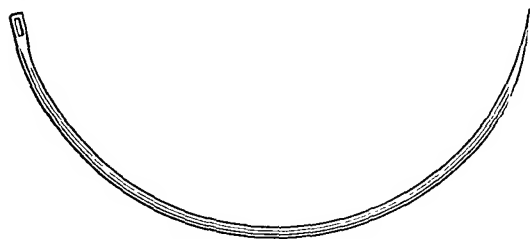


FIG. 15.—Corrugated needle to be held by the gloved hand for assuring a firm grasp in placing deep sutures for control of active hemorrhage.

(3) Being required to examine the liver for suture assures a more thorough examination.

*Advantages of Packing.*—(1) Easier and speedier.

(2) You can pack wounds that you cannot reach to suture.

(3) In case of secondary hemorrhage this can be recognized and treated earlier.

(4) In case of suppuration drainage is present at once.

The *indications* then are: Suture whenever there is no contra-indication, that is, in all smooth stab or rupture wounds accessible for suture, and when the condition of the patient allows time for doing it.

Use *tamponade* (1) in all gunshot tunnels; (2) in all tears or ruptures of the liver with contused, crushed or torn edges; (3) when the condition of the patient calls for quick termination of the operation, with the liver wound too large for suture, or when in an inaccessible situation; (4) in specially friable tissue; (5) when the liver wound is near the hilus and the larger vessels are torn and their ligation impossible.

## RÉSUMÉ

The liver is the most frequently injured internal organ. Its partial fixation, its shape and its composition render it easily injured. In children the liver is larger and more friable while at times they are more reckless as to danger.

Shock is of two kinds, (1) primary traumatic and (2) that due to the continued bombardment of the nervous system.

The sudden acceleration of the pulse to 140–160 due to fall of pressure is almost characteristic of internal hemorrhage.

As primary shock passes away the local symptoms determine the presence of an abdominal lesion. Abdominal dullness is the only positive sign of a lesion.

There is something sudden to a perforation while in peritonitis we have a distinctly gradual and progressive development.

## SUBCUTANEOUS RUPTURE OF THE LIVER

The diagnosis of liver lesions is often not possible until the next day. *If it cannot be based upon abnormal dulness then we must depend upon the disappearance of liver dulness produced by gradually developing tympanites caused by hæmatomas or injuries interrupting the nerve impulses at the base of the mesentery.*

Involuntary rigidity of the abdomen is a valuable reflex symptom and if watched will indicate which cavity, the chest or the abdomen, *has the severest injury as indicated by the predominance of its rigidity.*

Progressive vomiting is an indication of continued peritoneal irritation, or interruption of the peristaltic impulse. Internal hemorrhage is distinguished from visceral perforation by the predominance of the general symptoms of an acute anæmia over the local symptoms of a peritonitis.

Circumscribed spontaneous pain in the liver region, radiating shoulder pain, increase of liver dulness upward or downward, sometimes also decrease of liver dulness through meteorism, firm local blood collection, circumscribed rigidity in the liver region—all these point to the liver as the source of hemorrhage.

*Dangers.*—Hæmostasis of a liver wound is difficult because of the character of the tissue, because of the presence of bile, and because of the respiratory movements. Peritonitis is the intermediate danger; secondary hemorrhage, subphrenic abscess and empyema are the chief remote dangers.

The surgeon should watch the patient personally for several hours.

The mortality of liver injuries is at best above 40 per cent.

The median epigastric and Kausch diagonal incisions serve all purposes on the ventral surface. Displacing the right lobe out of the abdominal wound brings the lower surface into good view and access. The transpleural field is reserved for suture and packing of wounds of the dome and posterior surface.

By compression of the aorta and of the hepato-duodenal ligament the hemorrhage may be immediately checked.

The liver is fixed by packing it away from the diaphragm and costal border. Suture is the ideal method; packing for an emergency.

Post-operative nausea and vomiting may be due to compression of the hepatico-duodenal ligament, its blood-vessels or its splanchnic nerves.

The greatest skill is hæmostasis; the greatest error, hasty examination; the greatest virtue, speed.

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# INDICATIONS FOR SURGICAL TREATMENT OF MEGACOLON\*

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UNDER the terms Congenital Dilatation of the Colon, Hirschsprung's Disease, and the more general one of Megacolon, are grouped a number of conditions affecting the colon. These conditions are characterized anatomically by a total or segmentary dilatation of the large intestine with hypertrophy of the walls in the dilated zone. Barrington-Ward<sup>1</sup> points out that the term dilatation of the colon is incorrect in that it does not take note of the hypertrophy, which so usually accompanies the dilatation, and makes no mention of the involvement of the rectum, which is present in a considerable proportion of the cases. Hirschsprung,<sup>2</sup> who first directed general attention to the condition, advocated the term "true" megacolon for those cases manifesting symptoms in infancy and early childhood and "pseudo" megacolon for those cases occurring in later life.

There are many theories in regard to the etiology of the condition, but no single cause thus far discovered satisfactorily explains every case. The etiology, pathology and clinical features have been adequately discussed by a number of writers, notably Finney<sup>3</sup> in 1908. I shall limit myself to a consideration of treatment with special reference to indications for surgery and to the limitations of certain procedures employed.

It is convenient to divide into two classes the conditions which are grouped under the general term megacolon. True Hirschsprung's Disease, Congenital Idiopathic Dilatation of the Colon, is rarely observed. A proportion of the cases reported as such, prove on analysis to be instances of more or less localized involvement of the colon in which there is evident, the element of mechanical obstruction, anatomical or functional. Slight degrees of the congenital defect may apparently exist for years with few or no symptoms. Recognition may be due to accident or to the development of symptoms later in life.

In its typical form the condition is characterized by obstinate constipation with abdominal distention. The constipation is often noted from birth and abdominal distention may be present at birth, but more frequently appears in the second month or later. The greater number of these patients die in early childhood, but some reach adult life and even old age. The prognosis depends upon the extent of involvement and upon the age of the patient. The younger the individual, the more unfavorable the prognosis. The involvement is usually most marked in the sigmoid colon, but the entire large intestine or any portion of it may be the seat of the disease. Exceptionally a normal segment of intestine is present between two dilated portions. The rectum may be involved but is usually normal.

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\* Read before the New York Surgical Society, March 23, 1927.

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Males predominate in the proportion of three to one. Diagnosis is rarely difficult. As has been pointed out by Vernon David,<sup>4</sup> congenital stricture of the rectum may result in a condition similar in some degree to the so-called idiopathic dilatation of the colon. It is therefore essential in all cases to exclude the presence of such a stricture. Tuberculous peritonitis, chronic intestinal indigestion and rickets are conditions mentioned as causing confusion. In those rare instances when the patient first comes under observation in adult life, the abdominal distention is usually so great as to be distinctive. Röntgenography after an opaque enema is practically always conclusive.

The outlook is poor whatever the treatment, but inasmuch as compensation is occasionally established, a careful trial of medical measures is indicated. Such measures include a supporting abdominal belt, a low residue diet with restriction of starches, the avoidance of laxatives with the exception of mineral oil and the daily use of high enemas. Massage, electrical treatment and the administration of atropine may be employed. Dilatation of the anal sphincter sometimes proves of advantage.

If the condition is not improved or at least held in check, operation is indicated. Operation should be avoided if at all possible in the presence of obstructive symptoms and a bowel distended with faeces. When operation under such circumstances is inevitable, a preliminary colostomy may be indicated. Ordinarily, however, more radical measures give better results.

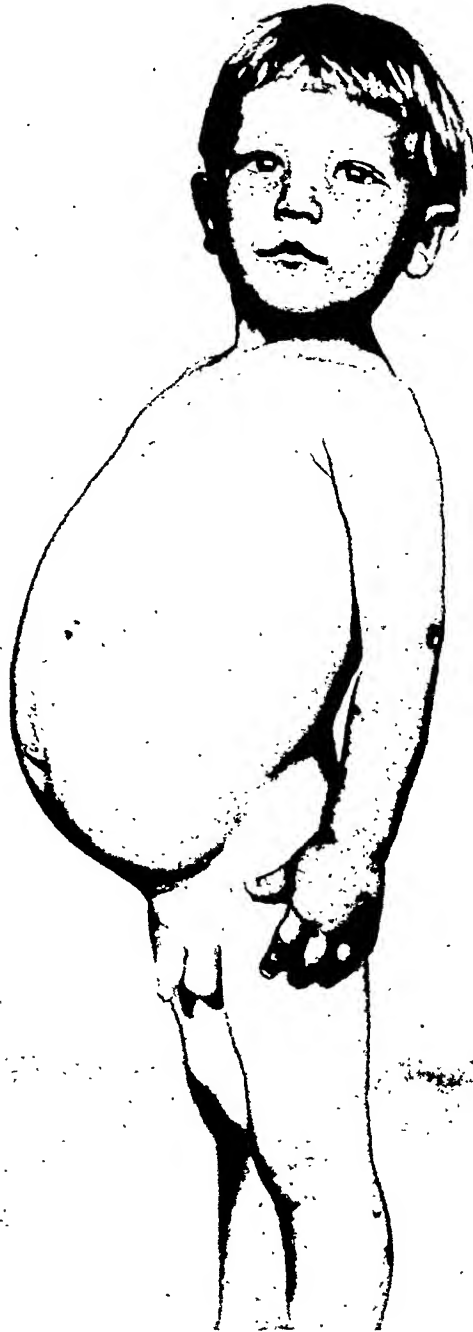


FIG. 1.—Congenital idiopathic dilatation of the colon (Hirschsprung's disease) in a two-year-old boy.

Procedures varying in extent from ileo-sigmoidostomy to total colectomy in one stage with the implantation of the ileum into the rectosigmoid have been advocated. The sequence practiced by Sistrunk,<sup>5</sup> Hubbard<sup>6</sup> and others appears, on the whole, to be the most promising. Following a lateral anastomosis between the ileum and the sigmoid, the ileum is cut across and both ends closed. Just above the anastomosis the sigmoid is divided, the distal end closed, and the proximal end brought out in the upper portion of the

abdominal incision to drain the excluded large intestine. The entire colon may be removed at a later date if the inconvenience of the fistula is such as to warrant this measure. Where the entire colon is not involved the procedure employed by Finney is applicable. This consists in a preliminary colostomy in healthy bowel. Subsequently a lateral anastomosis between the segments immediately above and below the distended portion is made and after complete recovery resection of the affected colon may be carried out.

CASE I.—The following case is typical of the condi-

tion. A boy of two was admitted to the Babies' Hospital in July, 1922, with a diagnosis of congenital dilatation of the colon. The history was of a normal delivery at term of a well-developed child. The child was breast-fed to ten months. At the age of three months obstinate constipation and enlargement of the abdomen were noted. With the aid of cathartics and enemas there were four stools a day, but otherwise there were intervals of four days without a stool.

On physical examination the child appeared in fair condition. The abdomen was greatly enlarged and protuberant and the xiphoid-umbilical measurement was much increased. Röntgen-ray examination after an opaque enema showed an enormous dilatation of the entire colon. No kinks or filling defects were noted. There was no indication of involvement of the rectum. After observation for a period of several weeks in the Out-patient Department and one month in the hospital, operation was decided upon. During this period daily enemas resulted in large, constipated or fluid stools.

August 12, 1922, the first operation was performed. Through a left rectus incision



FIG. 2.—Röntgenogram six hours after opaque enema in a case of congenital dilatation of the colon in a boy of six years. (Dr. Downes' case.)

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the sigmoid and descending colon were delivered. The diameter of the intestine varied between three and four inches and the wall was greatly thickened. The descending colon and sigmoid were resected and axial anastomosis was effected between the dilated proximal colon and the apparently normal rectosigmoid. The disparity in the size of the lumen made this a procedure of some difficulty. Rubber dam drainage was instituted through a stab wound. Convalescence was complicated by the development of a fecal fistula.

The child was discharged in good condition with wounds soundly healed six weeks after operation. At this time the abdomen was somewhat smaller than on admission. A few days later, however, the child was readmitted on account of increasing abdominal distention and the absence of stools. During this second stay in the hospital the abdomen increased steadily in size in spite of frequent apparently effectual colon irrigations. A second operation was undertaken one month later. Many adhesions were encountered. The terminal ileum was dilated and its wall thickened almost in proportion to the change in the large intestine. The ileum was implanted into the rectosigmoid and the remaining large intestine, with three inches of the terminal ileum was excised. Two days after this operation the child died of peritonitis. In the light of further study of the subject, I believe that an ileo-sigmoidostomy with exclusion and drainage of the colon would have been a more suitable operation.



FIG. 3.—Röntgenogram after opaque enema in same case as Fig. 2 nine years later at age of fifteen.

CASE II.—I am indebted to Dr. Wm. A. Downes for the history and röntgenograms of another patient who also serves to illustrate some of the phases of the congenital type. In 1917, a boy of six, was seen by Doctor Downes in consultation. There was a life history of constipation and abdominal enlargement. A röntgenogram revealed a greatly dilated colon, the condition being most marked in the sigmoid. The rectum was apparently not involved. At this time an abdominal belt and the usual medical measures were advised. During a period of nine years this boy has developed normally. Regular enemas are necessary, but with this exception he leads the normal existence of a boy of his years. His appearance is healthy and the only notable feature is a somewhat prominent abdomen. A röntgenogram made in October, 1926, reveals a generally dilated colon with an enormous sigmoid loop. A surgeon in another city has advised colectomy. Doctor Downes advises the continuance of conservative measures.

A case such as this affords a real problem. It seems reasonable to assume that there will continue to be a gradual progression of the condition and that

as middle age is approached there will be greater and greater difficulty in emptying the bowel. If surgery were undertaken nothing less than total colectomy or ileo-sigmoidostomy with exclusion and drainage of the colon would be adequate. There is little available knowledge as to the late results of these measures. It seems to me advisable in a case such as this to continue medical measures until there is evidence of increasing difficulty in emptying the colon at which time operation should be done. In the case of

patients not sufficiently responsible to carry out the necessary measures or whose social status is not such as to enable them to do so, operation is indicated at once.

To the second class, that of pseudo or acquired megacolon, belong by far the greater number of cases. The patients suffering from this condition usually come under observation late in childhood or in adult life. This type of megacolon may occur as a result of varied conditions; but is most frequently consecutive to a mechanical obstruction. The obstruction may be congenital, but the dilatation and hypertrophy of the large bowel is secondary and does not usually manifest itself in infancy. Redundancy of the sig-



FIG. 4.—Acquired Megacolon. Boy of six years. Röntgenogram four days after opaque meal. (Case of Doctor Kerley and Doctor Downes before operation for separation of adhesions.)

moid colon with subsequent rotation or angulation may result in chronic obstruction and consequent megacolon. A valve of mucosa may form at the point of angulation. Intestinal stasis with fecal impaction in the rectum is a further frequent cause. It is possible that the intestinal stasis is due to a congenital defect in musculature or innervation. It is this group which seems to me to offer the most intricate problems in the selection of suitable treatment. To begin with there is wide difference of opinion as to what degree of dilatation of the large intestine constitutes megacolon. Symptoms may be practically absent in a patient in whom röntgenography reveals an apparently greatly



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dilated colon, but may be very marked in another patient whose colon seems only moderately involved. Then, too, the normal, or redundant sigmoid, may be so distended by the injection of fluid under pressure, as to present a very deceptive picture. A great deal has been written about the subject. Nevertheless, few observers have had the opportunity of reporting on an extended series of personal cases and it is obviously difficult, if not impossible, to classify adequately, a group of cases derived from many and various sources. Furthermore,

with rare exceptions, little emphasis has been placed on the late results of treatment and there are available few well-grounded conclusions, helpful in discriminating between the indications for medical and those for surgical treatment. Save in the presence of acute obstructive symptoms, the first step in the treatment should consist in the correction of any anatomical cause of obstruction. It is true that, even though the obstruction be removed, medical measures will only exceptionally restore to normal a definitely dilated and hypertrophied colon. Careful medical treatment does, however, enable many



FIG. 5.—Röntgenogram after opaque enema in same case as Fig. 6 eleven years after operation for separation of adhesions.

patients with a very marked degree of megacolon to carry on their lives with little inconvenience from the condition. Such patients are obviously not subjects for radical surgery.

The following case serves to illustrate this phase of the subject, and I am indebted to Doctor Kerley and Doctor Downes for the history and röntgenograms.

CASE III.—At the age of nine months a baby came under the observation of Doctor Kerley. At that time he was suffering from a recurring intussusception involving the sigmoid and rectum. An exploratory operation was done and a band of adhesions extending from the umbilicus to the hepatic flexure was divided. At the same time the hepatic and splenic flexures were fixed to the anterior abdominal wall to prevent the recurring intussusception of the descending colon into the sigmoid. The intussusception did not

recur, but there gradually developed a dilatation of the entire colon. At the age of six and one-half years, Doctor Downes first saw the boy in consultation with Doctor Kerley. In February, 1916, Doctor Downes operated. The colon, from the hepatic flexure to the sigmoid was dilated. The oral end of the distended segment was attached to the anterior abdominal wall by adhesions and the distal end was kinked by an omental band. This entire segment was so twisted as to constitute a volvulus. The adhesions were freed and the volvulus reduced. Subsequent to this operation careful medical treatment has been persisted in. Eleven years after the operation the boy is well developed, normal in appearance and leads a normal life. He has a megacolon, but the condition

has been at least held in check and probably improved by the systematic and careful medical treatment he has received.

Where the rectum is involved and there is a tendency to fecal impaction, medical measures are often efficacious. In such cases there may be an enormously dilated sigmoid which is directly continuous with a similarly dilated rectum. It is unwise to resect the sigmoid in such a case save as a measure of urgent necessity in the event of volvulus. The diseased rectum remains and there is a marked tendency to persistence of symptoms and recurrence of a dilated sigmoid loop.



FIG. 6.—Röntgenogram twenty-one days after opaque meal. Megarectosigmoid with fecal impaction in a boy of fifteen.

CASES IV and V.—In the summer of 1922, two boys, one thirteen and the other fifteen years old, were admitted to the medical service of St. Luke's Hospital. In both the immediate history was of abdominal pain, diarrhoea and loss of weight. In the case of the younger, there was a history of stomach trouble and constipation since birth and he had been under observation at the hospital for a year, with recurring attacks similar to the present one. The older boy gave a definite history of only one month. In each patient there was an enormous fecal impaction with greatly dilated rectum and sigmoid colon. After the relief of the immediate symptoms the patients were transferred to the surgical service and assigned to me for treatment.

Resection of the sigmoid colon was carried out and a little over two feet of intestine was removed in each instance. This portion of the intestine was greatly dilated and the wall thickened. The process obviously involved the rectum. The remainder of the large intestine was relatively normal, though in one case considerably dilated. In this case an axial anastomosis was effected. In the other a lateral anastomosis was carried out on

## INDICATIONS FOR SURGICAL TREATMENT OF MEGACOLON

account of the great disparity in size of the dilated rectum and the apparently normal descending colon.

The immediate result in each patient was excellent, one gaining 22 and the other 29 pounds. There persisted, however, a marked tendency to constipation and in the second and third years after operation each patient had an attack similar in all respects to the ones before operation. Since that time there have been no attacks of such severity and although evacuation of the bowels is irregular, the condition is kept under fair control by the patients themselves.

Because of the tendency to recurrence of symptoms and of the dilated sigmoid loop after partial colectomy, Mirizzi<sup>7</sup> has advocated in such cases a total colectomy with implantation of the ileum into the sigmoid. As the procedure carries with it considerable immediate risk, and little is known of its late results, it seems scarcely justified in such cases as I have described.

In the event of the failure of medical treatment, I should incline to ileo-sigmoidostomy with the exclusion of the colon, and drainage through a colostomy. The colon may be removed at a subsequent operation if necessary.

A similar condition, in a greatly aggravated form, is apparently prevalent in Argentina, and in 1922, Corbin<sup>8</sup> referred to a personal experience of over 200 cases of fecal impaction with enormously dilated rectum and sigmoid. He stresses the almost inevitable recurrence of the condition after relief by medical measures. At times he finds it necessary to open the abdomen and remove the fecal mass either by crushing *in situ* or occasionally through an incision in the intestine. He considers partial or total colectomy not applicable and advises sigmo-rectal plication.

Where the rectum is normal the outlook is much better, and it is in segmentary dilatation of the colon with a normal rectum that surgery has its most favorable field. It is essential that the entire diseased segment be removed. The multiple stage operation of Mikulicz as carried out in such cases by Blake<sup>9</sup> and Dowd<sup>10</sup> is the method of choice, though resection in one stage may be done in very favorable cases. If the patient presents himself in an acute condition, it is of course desirable if possible to empty the distended bowel before operation is undertaken. In the event of failure, operation must be carried out and the measures determined by the individual conditions. The most frequent cause of acute symptoms in this type of megacolon is volvulus. If the condition of the bowel permits, reduction of the volvulus and delivery of the affected segment with a view to a Mikulicz resection is advisable. In many cases, however, this is impossible and the only resource is in an immediate colostomy.

### SUMMARY

I have referred to only five cases and yet they represent three distinct types of megacolon and the two cases of one of these types differ greatly in clinical features. This seems to me to illustrate the most characteristic feature of the problem presented by this condition. While the cases do fall roughly into certain groups, the lines are not well drawn either as to the character of the cases or as to the treatment each case requires. It is obvious

that a great diversity exists in the compiled series of cases which furnish the basis for much of the theorizing in regard to the relative value of medical and surgical treatment. It seems to me highly unreasonable to base a selection of treatment in an individual case on statistics resulting from the compilation of a series of cases differing in nature and degree and derived from widely separated sources. No general rule for treatment can be formulated. Type and degree of involvement, and to some extent the intelligence and social status of the patient must be carefully weighed. Medical and surgical treatment each have their indications and limitations and the treatment of each individual case must be decided solely on the merits of that case.

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# MUSCLE-FASCIA SUTURE IN HERNIA\*

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THE physiological result in the repair of inguinal hernia is dependent on several important factors:

1. The age of the patient, whether child, adult or aged. 2. The nature of the hernia, whether direct or indirect. 3. The complete removal of the sac. 4. Primary wound healing. 5. Efficient repair of the abdominal wall.

Although we have placed repair of the abdominal wall last in this list, it is by no means the least important. In fact, it is in relation to the surgical physiology and histology of this one factor that the following brief experimental study was undertaken.

Should red muscle be sutured to white fascia? As conflicting evidence

was found in answer to this question, we were impressed by the necessity of further investigation of the subject. Eminent surgeons could be found who said it was of value, while other surgeons, equally eminent, averred that it was of no value. Men of wide experience state that in their operations for recurrent hernia, the muscle had not adhered to Poupart's ligament; others state that they have seen firm union at re-operation. Seelig, for example, states that he has never seen the muscles and conjoined tendon firmly united to Poupart's ligament. He says, "In practically all instances these structures are widely separated just as if they had never been approximated by suture."

Seelig and Chouke, attempting to get at the basis of this problem by experimental studies on dogs, thought the inguinal canal of dogs so snugly and completely closed as not to permit of additional suturing, so they sutured a reflected edge of fascia lata in the thigh to the underlying muscle. They

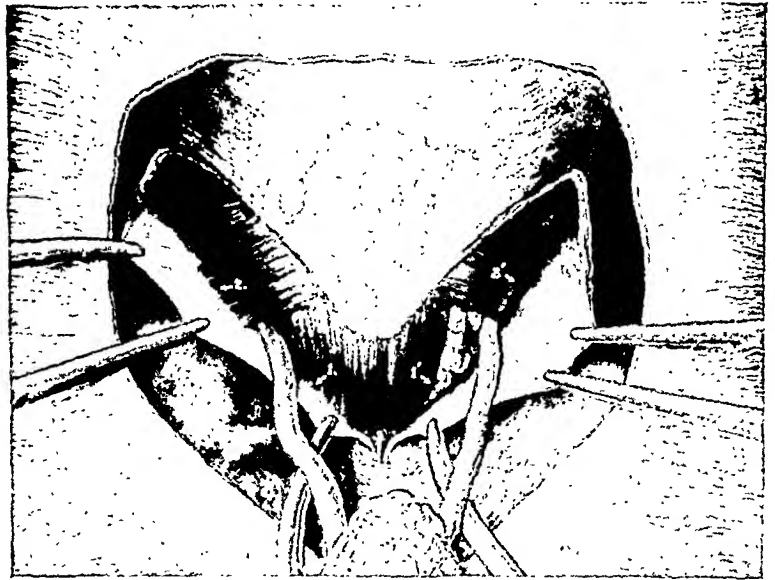


FIG. 1.—Both inguinal regions of dog, forty-one days after operation. 1—Edge of rectus muscle firmly adherent to Poupart's ligament. 2—Edge of internal oblique muscle firmly adherent to Poupart's ligament. 1' and 2'—The unoperated side.

\* Read before the Detroit Academy of Surgery, February 10, 1927.

say, "In every instance of clean wound healing, the fascia was widely separated from the muscle to which it previously had been sutured." They found that in infected wounds there was sometimes a partial cicatricial union. Even



FIG. 2.—Both inguinal regions of dog, sixty days after operation. Right side operated. Firm union of muscle to fascia.

on cutting wedges in the muscle and then inlaying fascia, they concluded that a full measure of success could not be obtained, although no tension was placed on the muscle-fascia suture. Their final conclusion was that normal muscle will not unite firmly with fascia, and that it is a useless procedure to suture the muscles to Poupart's ligament in the repair of a weak abdominal wall.

Edmund Andrews agrees with Seelig and Chouke that such union does not occur, and that, theoretically, it would not be expected to occur. He considers it harmful to suture the internal oblique muscle to the ligament, and says that this muscle acts as a sphincter to close the inguinal canal, and that sutures damage the muscle.

Being familiar with the work of Seelig and Chouke, we attempted to repeat their procedure on the thigh of dogs, and endeavored also to find a satisfactory technic in the inguinal region for muscle-fascia suture. While involved in this attempt, we became acquainted with the admirable work of Koontz,



FIG. 3.—Both inguinal regions of dog, seventy-seven days after operation. Left side operated. Sutures show where muscle was approximated to the aponeurosis of the external oblique. Firmly adherent.

who had also repeated the work of Seelig and Chouke with certain modifications. Koontz concluded that the internal oblique muscle and Poupart's ligament unite firmly in the dog, when these structures are brought into

apposition by suture. And he further stated that the fascia lata, when sutured to the underlying muscle, also united firmly if the areolar tissue was carefully removed before suturing.

Gallie and LeMesurier had previously found that even in fascia to fascia suture the areolar tissue should be removed, as otherwise the strength of union would be slight. They conclude also, "That fibrous tissues heal to whatever structures they are placed in contact with, by ordinary scar. The strength of the scar depends on the degree to which the surfaces in contact are denuded of areolar tissue and scarified, and on the area of the surface."

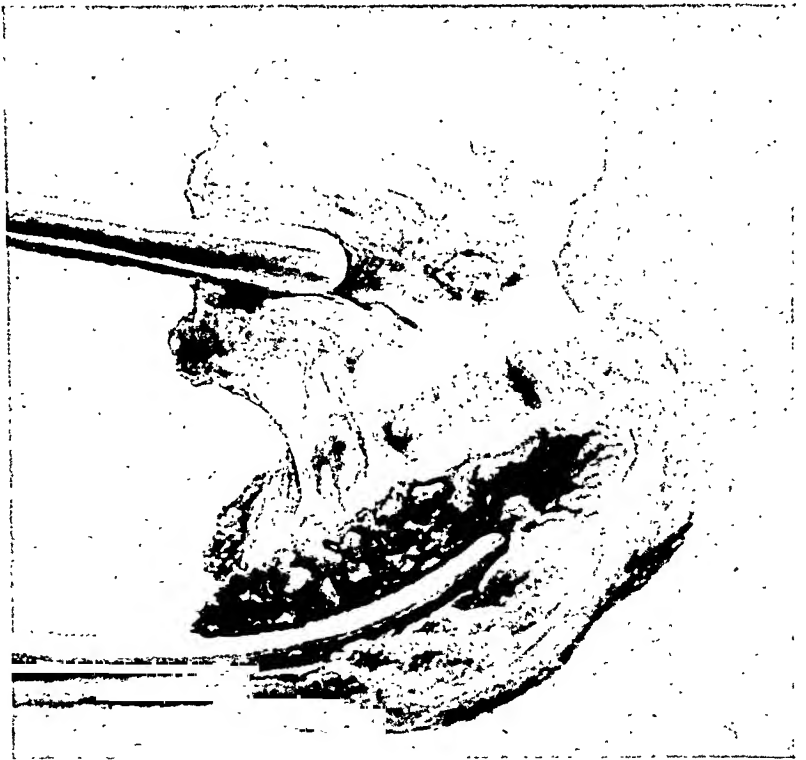


FIG. 4.—Thigh of dog, fourteen days after operation: areolar tissue not removed before the suture of muscle and fascia. No serviceable union.

Twenty-seven operations were performed by us on dogs, ether anaesthesia being used. As the inguinal region in dogs is different from that of man, we

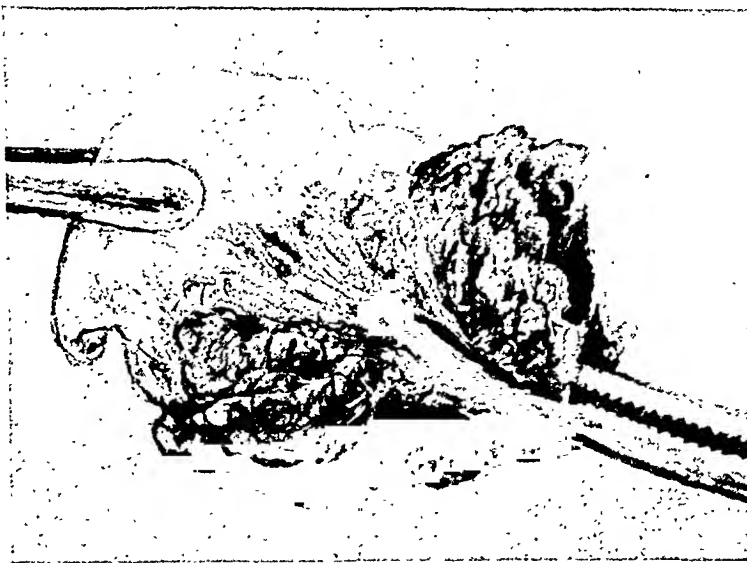


FIG. 5.—Thigh of dog, fourteen days after operation: areolar tissue removed before suture of muscle and fascia. Firm, serviceable union.

were unable to follow the usual technic of hernia repair. In dogs the internal oblique muscle fibres run almost at right angle to Poupart's ligament, and are not attached to it. The rectus muscle, as in man, is attached for a very short distance to Poupart's ligament, while the conjoined tendon is evident for a distance of only 0.5 to 1.0 cm. from the pubes.

In our operations, the edge of the rectus muscle was brought over and sutured by interrupted single sutures of twisted silk, to Poupart's ligament, the fascia of the external oblique having been incised as in any hernia repair, and the areolar tissue

elements being gently stripped from the muscle and Poupart's ligament before suturing.

In some cases the cord was transplanted, and in some cases it was not. Also, the internal oblique muscle was sutured to the reflected margin of

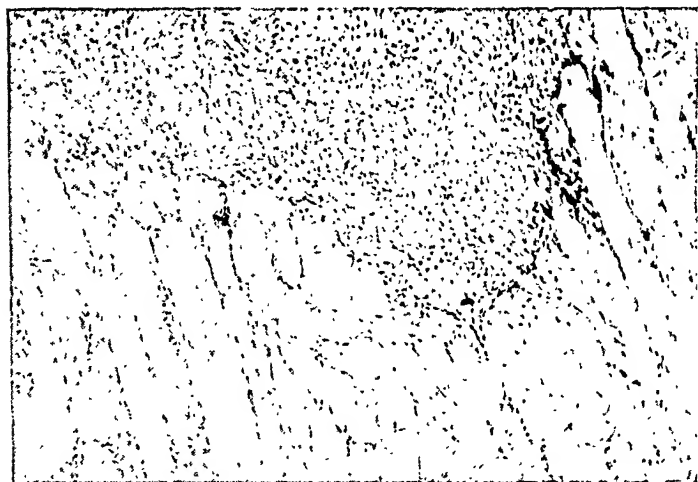


FIG. 6.—Photomicrograph, low power, showing the union of aponeurosis with fascia between and around muscle fibres—many tentacle-like strands anchor the aponeurosis.

muscle and fascia resulted in all cases, and was of such character that muscle could be torn from muscle as easily as the union between muscle and fascia could be overcome. All cases were the same, for there were no exceptions. One case, because of severe infection and death by pneumonia, is not included.

In the thigh operations, the anterior iliac fascia was incised, reflected and sutured, so that a counterpart of Poupart's ligament was constructed. On one side of the dog this was sutured to the underlying muscle without removal of the very evident areolar tissue intervening in this region. On the other side the same procedure was used, except that the areolar tissue on the fascia and muscle was carefully removed. The latter side in all cases showed good union of muscle to fascia, whereas the side in which the interposing areolar tissue was not removed, showed very slight union in only one case. (See Figs. 4 and 5.)

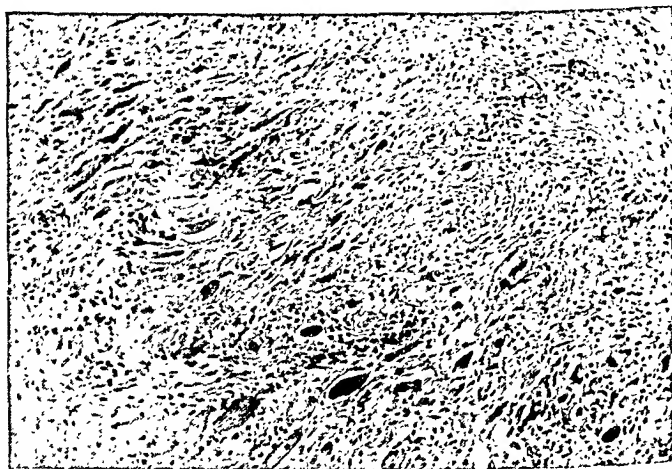


FIG. 7.—Photomicrograph, low power, showing replacement of a few muscle bundles by fibrous tissue, and the union of this with the aponeurosis and the tentacle-like strands in and around the muscle.

We feel, therefore, that the success of the muscle-fascia union depends



## MUSCLE-FASCIA SUTURE IN HERNIA

on the complete removal of the interposing elements of areolar tissue and fat. To allow this synovial-like membrane of areolar tissue to exist between the sutured elements is to invite just that situation existing in a joint, non-adherence of insulated structures. The term, muscle-fascia union, is misinforming, and has probably caused a portion of the controversy existing on this subject. Despite the fact that one sutures muscle to fascia, the union is as fascia to fascia. Of course one does not expect a red muscle cell to become a white fascia cell. The muscle bundle, however, is surrounded by a sheath of white fibrous connective tissue and each muscle fibre has its neighbor bound to it by the same element, while the entire muscle or group of bundles is likewise held together by white fibrous tissue. The elements for a connective-tissue union are therefore present. As a matter of fact, when muscle is sutured to fascia, without interposing tissue, two things happen: 1. The fascia forms communications with the myomysium, endomysium and perimysium (the white fibrous tissue in and around the muscle). Radiating processes project from ligament to muscle, binding the two firmly together by hundreds of interlacing tentacle-like strands.

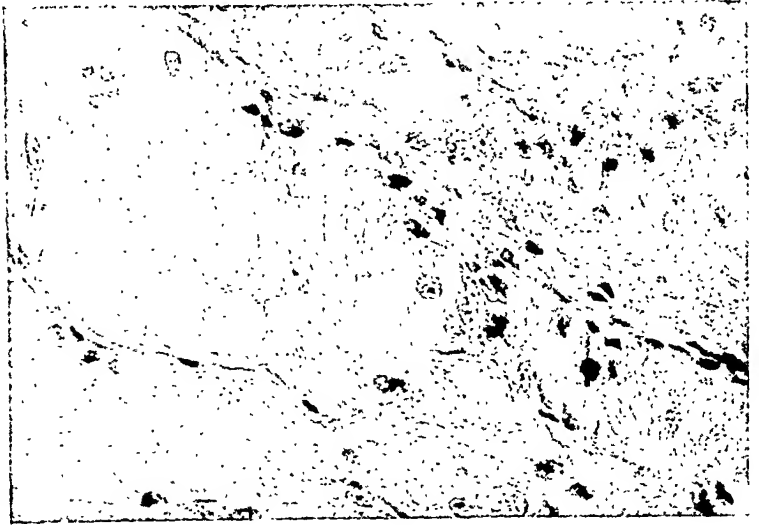


FIG. 8.—Photomicrograph, high-power, showing white fascial cells in and around the muscle bundles. The elements for a true, firm connective tissue union are therefore present.



FIG. 9.—Photomicrograph, low power, showing sutures in field of union.

2. A portion of the muscle in contact with the ligament is partly replaced by fibrous tissue. This fibrous tissue

is firmly connected with the fibrous elements above mentioned, and with the ligament. This is shown in Figs. 6, 7, 8, 9 and 10.

Andrew's criticism that you destroy the sphincter action of the internal oblique by suturing it to Poupart's ligament seems untenable, for, by so doing one actually keeps the sphincter closed—if it really is such. That you

injure nerve supply and damage the muscle, is not a pertinent objection, if very small portions of the muscle are included in the suture. The muscle may be very slightly replaced by the fibrous tissue at the point of union, but this is advantageous, and makes for firm union.

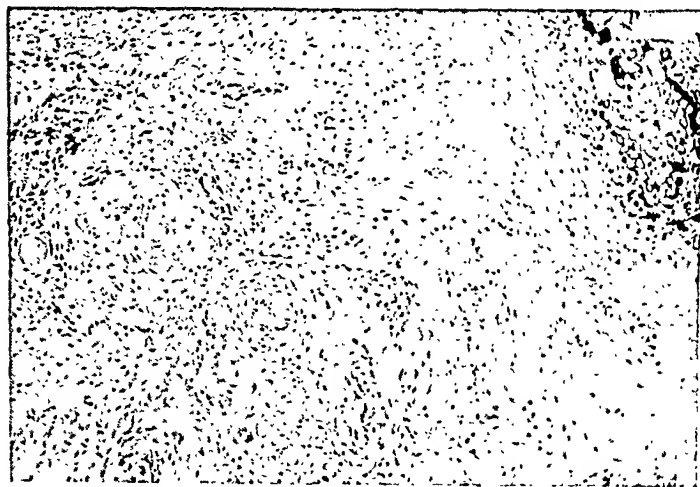


FIG. 10.—Photomicrograph, low power, showing sutures in field of union.

We do not mean to infer that it is advisable or necessary to suture muscle to fascia in all cases of clinical hernia. The ligation of the sac, the overlapping of the fascia of the external oblique or the method of Pitzman, in which the transversalis fascia is used, may be independently or collectively sufficient in given cases.

In severe direct hernia, the more elaborate technic of Gallie and LeMesurier may be decided upon. We do feel, however, that if it appears to the surgeon that a firm union between Poupart's ligament and the rectus or internal oblique muscles would be of advantage in repair, that this union may be assured if the areolar tissue is removed before suturing.

#### CONCLUSIONS

1. In the literature of hernia, the advisability of suturing red muscle to white fascia is questioned.

2. When done experimentally, firm union resulted in dogs in all cases in which the areolar tissue was removed from the muscle and fascia before suturing. On the thigh of dogs no union occurred when the areolar tissue was left intact.

3. The general type of union is the same as that between fascia and fascia.

4. In hernia, it is not always necessary to suture muscle to fascia, but when indicated, may be relied upon if areolar tissue is first removed.

NOTE: Since the reading of this paper, Major Seelig has again reiterated his stand on this subject.

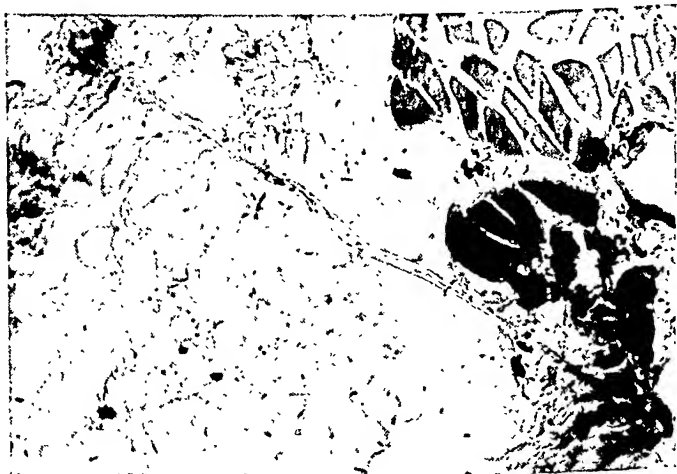


FIG. 11.—Photomicrograph, low power, showing the very evident areolar tissue in an unoperated specimen.

# MUSCLE-FASCIA SUTURE IN HERNIA

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# THE PROBLEM OF RECURRENT HERNIA

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WHEN the word hernia was substituted for rupture as referring to sac formation in the inguinal, femoral, umbilical and other locations, it was also applied to the state of affairs following post-operative rupture, or separation of the edges of the peritoneum, muscles and fascia of the abdominal incision made for previous operation. The term "recurrent hernia" has been long and abundantly employed. Have surgeons generally taken the trouble to inquire if the real state of affairs was that of peritoneal sac formation, or rupture of the previous incision?

For many years I have contended that post-operative incisional hernia is a true rupture of the abdominal wall resulting from incomplete or insecure closure of peritoneum and fascia, or the breaking of sutures by such violent and sudden efforts as coughing, vomiting, etc., or the imperfect healing of wound edges as a result of suppuration. This contention can be proven in every case by painstaking naked eye examination at the time of operation. There will be found a break of continuity of the peritoneum and fascia at the site of the previous incision. After a year there will be found at the second operation an easily identified sac which, to superficial examination, resembles in its smooth appearance, the peritoneum. Careful examination, however, shows that it is not true peritoneum and that the line of demarcation between the sac and the true peritoneum can usually be clearly defined. More detailed study of the sac will show that it is ordinary fibrous tissue, much thicker than peritoneum; microscopic examination of a carefully prepared specimen will show that it is not lined with endothelium and does not possess the histologic structure of serous membrane. The sac of this type of rupture is a newly formed fibrous structure, a product of adaptation of the connective-tissue cells of the abdominal wall adjacent to the hole in the abdominal wall and not an outgrowth of peritoneum.

Of "recurrent hernia" there are at least three easily recognizable types. One of these is in no sense a true hernia of peritoneal sac but a post-operative incisional rupture. Because it occurs after an operation for hernia gives us no more reason to think of it as a new hernia formation, than is an ordinary post-operative incisional rupture in some other part of the abdomen. The prevention of this necessitates accurate close suture of the peritoneum, the avoidance of wound infection and of excessive and sudden violent efforts which will produce breaking of sutures and tearing of tissues.

Another and extremely common type of so-called "recurrence" is that in which all the sac of the hernia has not been removed at the primary opera-

tion. This can and does occur even in the hands of the best surgeons when removing the sac from below in the routine way as is commonly employed. The neck of the sac is not tied or sutured sufficiently high. In dealing with large herniæ even the expert surgeon does well to be cautious lest he pull the bladder down and ligate or suture a part of it with the sac, especially of direct hernia and amateurs will do well to obey the impulse of timidity in pulling down with inexperienced hands the sac with the bladder, vas deferens, deep epigastric, and vessels of the spermatic cord in close relation. Actually there are a large number of cases in which at the original operation for indirect hernia the entire sac was not completely separated from the surrounding fascia and had been ligated or sutured at a point not sufficiently high, leaving an inch or more of the original hernia in the inguinal canal. This as time goes on, grows to large size.

The most common example of so-called "recurrence" is at the lower angle of the inguinal canal having the appearance of a direct hernia. These are now recognized as bulging of redundant peritoneum at the location of direct hernia existing at the time of the first operation with the indirect hernia, for which the previous operation was performed. These, therefore, are not true recurrences of hernia, but only the inner sac of the originally present hernia which had never been removed.

The following cases illustrate the different types:

CASE No. 23—4322.—A young man was believed to have on the right side an inguinal hernia about the size of a hen's egg and on the left side about the size of an almond. Superficial examination on my part failed to find the hernia on the left side. At operation, through a muscle-splitting incision, into the abdominal cavity an inch above the internal ring on the right side, the hernia was easily recognized and completely removed and the inguinal canal closed under the cord. I doubted if he had a hernia on the left. The man was so sure that he had a hernia on the left side that I explored the left side, made a hasty superficial examination, failed to find a hernia and closed the abdominal wall without further disturbing the inguinal region. Six or seven months later he returned. The second operation found on the left side a small sac about the size of an almond and a neck about the size of a lead pencil. He is now completely cured.

This was in no sense a recurrence, but the same hernial sac which he had originally and which on account of haste and carelessness I overlooked entirely.

2. CASE No. 22—4207.—A man, sixty odd years old, thought he had hernia of both inguinal regions. He was thin, his muscles were weak and there was obvious an inguinal and a femoral hernia both on the right side, and bulging, but no true hernia, on the left. Through a muscle-splitting incision an inch above the neck of the hernia on the right side there was found an inguinal hernia about the size of a hen's egg and a femoral hernia about half that large. These were both removed from within. The peritoneum was closed and the canal closed under the cord (Bassini). On the left side, through a similar incision, careful examination showed that there was no hernia, but to prevent subsequent bulging, the canal was closed under the cord as usual. Following the operation there was extensive wound infection on the left side. About six months later he developed a large ordinary post-operative incisional rupture on the left side coming through the original muscle-splitting incision at least an inch above the position of the

internal ring but never going into the inguinal canal. I heard from his doctor that he subsequently went to another surgeon and was operated upon for rupture.

Here is a case of true inguinal and femoral hernia both on the right side; no hernia at all on the left. Following operation the two herniæ on the right side were permanently cured and on the left, where there was no hernia, the man developed, as a result of wound infection, a typical post-operative rupture.

CASE No. 24—4534.—A man came for operation for left inguinal hernia and had a severe acute "cold" when he entered the hospital. He was kept in bed three days for this to subside. The operation was done in my usual way through a muscle-splitting incision into the general cavity an inch above the neck of the hernia, the sac completely and easily removed, the inguinal canal closed under the cord (Bassini). Promptly following operation he had pneumonia with violent cough and said he felt the inside stitches break. There was no wound infection and no bulging was noticeable when he left the hospital. Six months later he noted a "rupture" and a year or so later returned to me for operation. The operation was performed through the same incision into the peritoneal cavity. There was no neck of hernia but a separation of the edges of the peritoneum at the previous point of suture. The edges of the peritoneum were easily freed, brought together and resutured and the inguinal canal was reclosed under the cord (Bassini). The cure was permanent.

This was a case of true post-operative rupture from suture breakage incident to post-operative pneumonia.

CASE No. 26—5552.—A young man came for operation for recurrent bilateral hernia. He had been operated upon elsewhere two years previously, both wounds were followed by extensive suppuration and in six months following the operation he had a "recurrence" on each side. When first noticed they were of small size but gradually grew until the left side was nearly the size of an adult fist and the right side somewhat smaller. The operation for the "recurrence" was done through the usual muscle-splitting incision into the peritoneal cavity an inch above the neck of the hernia. On both sides there were found typical hernia necks such as we see in practically every case of indirect hernia. The original herniæ had not been removed. There were no adhesions. The peritoneum of the general cavity extended an inch into the canal on each side; beyond this there was found the fibrous tissue sac which goes with every post-operative incisional rupture of more than a year's standing. I excised from above one inch of redundant peritoneum around the neck of each hernia and removed the sacs, pulling them up from within. Both canals were re-closed by suturing the upper leaf of the aponeurosis to the shelving edge of Poupart's ligament under the cord, using a fascia suture on the left and catgut on the right. After removal the sacs were examined and the points of junction of the true peritoneum with the fibrous tissue sacs were easily seen by the naked eye.

This was a case of combined incompletely removed hernial sacs and post-operative incisional rupture.

#### CONCLUSIONS

True abdominal hernia is peritoneal sac formation resulting from anatomic growth, *i.e.*, congenital. This concept of hernia is well nigh universal. And yet in discussing the subject even with surgeons, one is forced to wonder if the full significance of this belief is adequately comprehended. A finger,

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an appendix vermiformis, a hernia; any anatomic formation once removed, never reforms.

"Recurrent hernia" represents the incompletely removed original hernia, or the development of incisional rupture following breakage of sutures or tissues by coughing, vomiting or wound infection. This conception of recurrence makes clear the fundamental principles involved in its prevention and cure. The surest way to avoid the need of a second operation to remove a hernia is to remove all the sac and redundant surrounding peritoneum at the first operation. I have described an extremely simple, safe and efficient method of accomplishing this and have employed it in more than twelve hundred cases. An incision is made directly into the peritoneal cavity above the hernial orifice giving a good exposure of the neck of the sac, the surrounding loose redundant peritoneum and neighboring structures. By this method one is enabled to study the anatomy of the hernia and the region involved with a satisfaction vastly superior to the old method of isolating, pulling down and removing the sac from the outside and with no danger to neighboring structures. A circular incision is made through the peritoneum above the hernia enabling one with great ease to pull the entire hernia up out of the canal and scrotum and to know at the conclusion of the operation that the entire hernia is removed and the peritoneum sutured one or two inches above the orifice of the inguinal canal.

For the cure of a hernia which has been operated upon but not removed, the operation consists chiefly in the removal of the hernia and the surrounding peritoneum and this can much more easily be done through a muscle-splitting incision one inch above the inguinal canal above the scar tissue of the previous operation in exactly the same way as is described above. For post-operative incisional rupture the same operation from above gives easy access and facility for suture of the hole in the wall. The inguinal canal, greatly enlarged as a result of tissue sloughing, had best be repaired by the suture implantation of fascia from the external oblique by the method of McArthur or from the thigh according to the method of Gallie.

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# RECURRENCE AFTER OPERATION FOR OBLIQUE INGUINAL HERNIA IN THE ADULT MALE

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THE recurrence of oblique inguinal hernia has been variously estimated over a long period of years. Statistics published by many operators from various clinics indicate a rather wide differential in the percentage of unsuccessful operations.

In 1923, Erdman<sup>1</sup> reported 21 recurrences, 3.15 per cent., in 665 operations for oblique inguinal hernia in males. In 1918, W. B. Coley and Hoguet<sup>2</sup> reported the results on a series of 6090 operations for hernia at the Hospital for Ruptured and Crippled. Of this number, 4420 were for oblique inguinal hernia in the male. There were 25 recurrences—5.7 per cent. In 1923, Hoguet<sup>3</sup> reported sixteen recurrences, 1.6 per cent, in 963 operations of indirect inguinal hernia in males over fifteen years of age. In 1924, B. L. Coley<sup>4</sup> reported 28 recurrences, 8.7 per cent., in the 332 patients who reported after 1155 operations for indirect inguinal hernia in the adult male.

It is evident from this selected statistical data that opinion regarding the recurrence of inguinal hernia is at variance. Not only do different authors vary in the percentage of failures reported, but the same authors, reporting at different times, give widely different figures.

It has frequently been stated that a patient, unsuccessfully operated upon for hernia, will not return to the surgeon or clinic responsible for the operation, but will seek relief elsewhere. This fact has been emphasized from time to time and held responsible, in a measure, for the small number of recurrences reported from certain clinics. This may or may not be an accurate statement. Assuming, for the sake of argument, that a majority of these patients do seek relief elsewhere, it is logical to deduce that the law of averages would bring approximately the same number of recurrences to each clinic. Eventually, therefore, they would all find their way into statistical data; and "statistics can be made to tell anything—even the truth."

In limiting this survey to the indirect type of hernia occurring in the adult male, we feel that it offers a basis for constructive reasoning. These operations were all done between January, 1921, and January, 1926, at the New York Post-Graduate Hospital, on the service of Dr. Charles Gordon Heyd. They were performed either by Doctor Heyd or myself, and the Bassini technic, or some modification of it, was used in each instance.

In this series, letters were sent to 576 patients, and 148 were returned by the post office because the individuals could not be located. Four hundred and twenty-eight letters were apparently delivered, and there were 266 replies



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received. An uncertainty, as to whether or not a cure had been effected, rested in the minds of 48 patients. They all accepted the invitation for a free examination to clear up this point.

There were two deaths in the series; one due to pulmonary embolus and the other to lobar pneumonia. There were 258 cures, and 6 recurrences—2.255 per cent. Two of these were at the internal abdominal ring and four at the external abdominal ring.

While the percentage is lower than that reported by some operators, it is somewhat higher than that reported by others. It is slightly better than the average of the recurrences reported by twelve different surgeons during the past ten years.

Of the many causes for the recurrence of hernia, infection is, perhaps, the most frequent. In the presence of pus-producing organisms, there is the sloughing of tissues, the very early dissolution of the suture material, and a wide separation of the structures recently approximated. It is then only a matter of time—and generally a very short time—until the bulge in the inguinal region is larger than before operation.

Closely allied to infection, but of less importance, is the lack of complete hæmostasis. A moderate or large size collection of blood in the inguinal canal can, by purely mechanical means, so distort the structures as to prevent a proper union, and subsequently permit a new sac and its contents to protrude. If such a hæmatoma fail to produce a recurrence mechanically, the probability of a superimposed infection is ever present.

The higher the ligation of the sac, the more likely one is to effect a cure, and vice versa. When the neck of the sac is ligated and the suture cut, it should slip into the abdominal wall and disappear from view. This, of course, predicates a meticulous and complete freeing of the neck of the sac from all the surrounding tissues. If this procedure be not properly executed, a recurrence is present before the operation is completed.

Moschcowitz and Erdman have reported recurrences due to the slipping of the ligature or suture from the neck of the sac. It must be apparent that this accident can occur. Secondary operation, in such a case, would reveal the hernial contents without a sac and covered only by loose fibrous tissue.

The internal oblique muscle must be thoroughly mobilized and easily approximated to Poupart's ligament. If this be not the case, then undue tension will be made to slide the muscle into position. This will result in a partial or complete strangulation of the fibres involved. There will then be no union, or only a weak fibrous one, between the internal oblique muscle and Poupart's ligament. If, under the undue tension, union does take place, it is likely to do so at the expense of a split in Poupart's ligament. Either of these two factors quite easily leads to a recurrence.

Persistent vomiting is reported as an important cause of recurrence. The writer has had no experience along this line, but he would not be inclined to feel that vomiting alone could be responsible for recurrence. With contributing factors, however, such as poor musculature, improper transfixion of the

sac, etc., it would seem perfectly possible for violent vomiting to furnish the final strain to destroy the repair. The proper application of adhesive straps, which, within limits, fix the abdomen, will generally take care of considerable strain due to excessive vomiting.

Poor musculature—especially a slender, anæmic-looking, fat-streaked internal oblique—is a definite and important cause of recurrence. In the face of an inadequate internal oblique muscle, something further than the usual type of operation should be performed. If this be not done and a recurrence results, then the cause should be laid to a lack of surgical judgment.

Accidental injury to the ilio-hypogastric nerve, resulting in paralysis of the internal oblique muscle, is reported as an important cause of recurrence. This explanation hardly seems tenable in face of the experiments of Edmund Andrews<sup>5</sup> proving that “all the motor fibres are given off before the nerve (ilio-hypogastric) enters the field of operation for hernia, and that, therefore, accidental section of this nerve will not cause any paralysis of this muscle.”

Any acute infectious disease, particularly pneumonia, occurring soon after operation, has a deleterious effect upon the recent repair. Any absorbable suture material will dissolve more rapidly in the face of a general infection than under normal conditions. Such an infection, therefore, must be looked upon as a definite contributory cause of recurrence.

During the past few years, stress has again been laid upon the fact that suturing the internal oblique muscle to Poupart's ligament is based upon unsound principles. Oudard and Jean<sup>6</sup> go so far as to state that the Bassini operation should be abandoned. Recommendations vary from a fascia to fascia approximation (Seelig and Chouke),<sup>7</sup> to the use of strips of fascia or living tissue for suture material (McEachern).<sup>8</sup> The consensus of opinion, however, seems to be that these views are rather exaggerated and the resultant recommendation to be used only in selected cases. As referred to earlier in this article, an anæmic, fat-streaked muscle will need more than the usual Bassini repair if a cure is to be hoped for. For the usual type of case, the approximation of muscle to fascia seems to serve admirably.

The repair of an inguinal hernia is generally quite simple. Every surgeon worthy of the name has done hundreds of them. For these two reasons, it is generally this operation that falls as the first fruit of his endeavor to the house surgeon. This is both logical and just, for we have all had to do our first herniotomy. But we must not overlook the fact that this is probably an important factor in judging the causative agents of any unduly large percentage of recurrence. I do not know that this factor has been previously referred to by anyone.

We are of the opinion that the Bassini technic for the repair of inguinal hernia is applicable and sufficient in the vast majority of cases. In the aged, where the musculature is weak, and in individuals with anomalous conditions, the Bassini technic, together with one or more of the numerous recommended modifications, will suffice.

A concentrated effort at perfection with the Bassini operation will, we

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believe, give much better results than the continued search for a new technic. It has stood the test for forty years. It has been performed under all conditions by countless operators with a wide range of experience—from none up. In the face of this, we think the percentage of recurrence to be very low, perhaps not much greater than one would expect, taking into consideration the human equation.

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# THE SURGICAL SIGNIFICANCE OF THE RECTO-SIGMOID SPHINCTER\*

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IN CERTAIN portions of the alimentary canal the onward passage of ingesta is habitually delayed. This delay, having its obvious physiological purposes, is caused by a localized tonic contraction of the encircling musculature of the gut; and is so correlated with segmenting and propulsive peristaltic movements

that when the purpose of the delay has been accomplished the constricting fibres are inhibited, and the visceral content is thrust onward.

A sphincter muscle is habitually in a state of tonic contraction incident to the control maintained by its intrinsic ganglia; accentuated or inhibited by its sympathetic and parasympathetic nerve supply. Irritation either direct or reflex increases its tonus.

It is not completely competent against continued pressure of fluids.

Its hypertonus may cause pain as may the hyperperi-

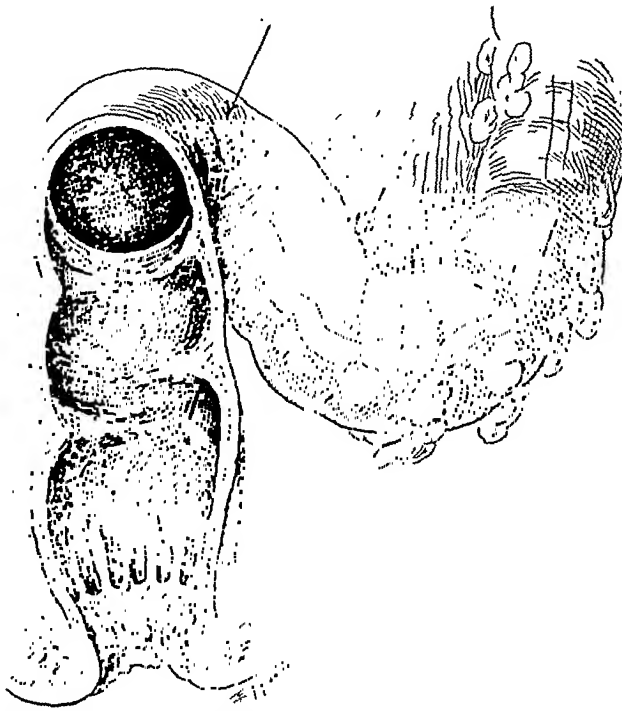


FIG. 1.—Location of the recto-sigmoidal sphincter which is about six or seven inches above the anus.

stalsis developing in the effort to overcome the resultant obstruction. This pain may be severe, is usually intermittent, is referred to or about the seat of muscular spasm.

The stasis caused by a persistently hypertonic sphincter may be relieved by overstretching or by section of the muscle at fault.

Hypertonus of the cardiac sphincter (cardiospasm) may be so pronounced and persistent as to cause œsophageal dilatation and death by inanition. It is cured by overstretching this sphincter.

The infantile form of hypertonus of the pyloric sphincter in its grave

\* Read before the American Surgical Association, May 13, 1927.

## SURGICAL SIGNIFICANCE OF RECTO-SIGMOID SPHINCTER

form causes death by dehydration and starvation. If inhibition does not develop under proper diet, it is cured by cutting the sphincter.

The pyloric hypertonus of the adolescent and adult, a common cause of chronic indigestion, dating from infancy, has many times been cured by overstretching or by cutting the sphincter.

Hypertonus of the recto-sigmoid sphincter, causing that enormous dilatation of the sigmoid and colon called Hirschsprung's disease in the infant and adolescent, megalocolon in the adult, by analogy may be cured by cutting or stretching the sphincter.

The sigmoid colon, beginning on the left side at the crest of the ilium and terminating opposite the third sacral vertebra; with a parietal mesenteric attachment of three and one-quarter inches and a visceral one of nineteen, has the widest range of motion of all abdominal viscera. It usually occupies a pelvic position, its distal end forming an acute angle with the fixed rectum. The recto-sigmoid sphincter is situated just proximal to this juncture.

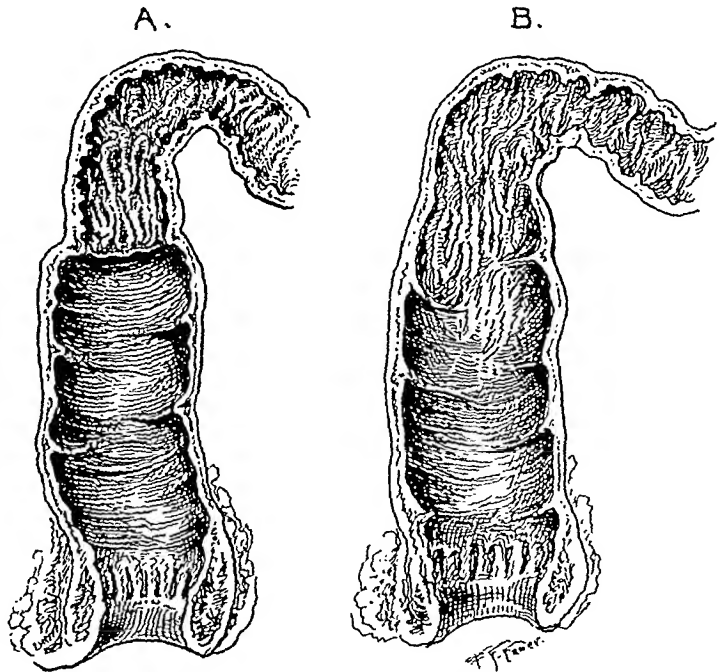


FIG. 2.—A. Shows a well-defined change in the appearance of the bowel at the recto-sigmoidal juncture which is similar to that at the gastro-duodenal juncture. It is found in only a small percentage of cases. B. Shows the more common appearance of this region in which the transition from sigmoid to rectum is more gradual.

As a rule the sigmoid has a well-developed musculature exhibiting no local increment of circular fibres to suggest an anatomic sphincter, nor a constant perceptible narrowing at the recto-sigmoid juncture. In the opened bowel (31 specimens) 12 showed a distinct and abrupt transition in the appearance of the mucous membrane between sigmoid and rectum similar to that at the pylorus, and a distinct narrowing at this point. This change was not seen in the remaining cases nor did it always coincide with the recto-sigmoid juncture, but varied from a distance of four centimetres to thirty-one centimetres from the anus.

In the sigmoid occurs the final delay preceding the act of defecation. Until the rectum is perverted by habit, material in bulk within its lumen excites the desire to expel it. When the contents of the sigmoid pass into the rectum through an inhibited sphincter, adequate defecation may empty not only the rectum and sigmoid, but the colon as well.

The form of recto-sigmoid sphincterismus known as congenital idiopathic dilatation of the colon or Hirschsprung's disease, becomes manifest in the early weeks or months of life by obstinate constipation, great enlargement of the abdomen usually beginning on the left side, visible peristalsis and pro-

gressive emaciation and weakness. In cases where efforts to empty the colon have been successful, the individual may live to adult age subject to periods of prolonged constipation with enormous distention of the abdomen. The rectum is usually empty and röntgenograms made after an opaque enema show great dilatation of the gut.

More than 400 cases were reported up to 1918, and various types of operation have been and are being performed, having in the main for their object removal of the colon.

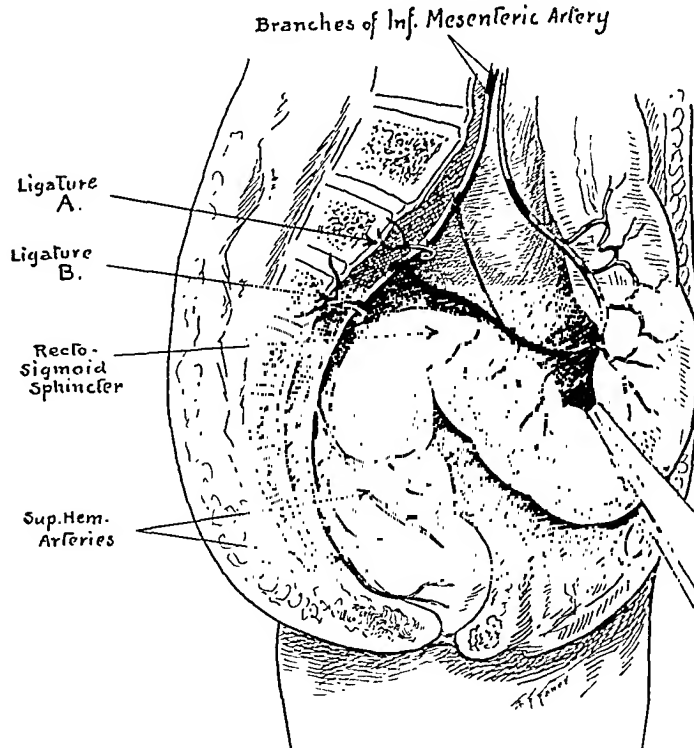


FIG. 3.—Blood supply of sigmoid and upper rectum from inferior mesenteric artery. Ligature at A is safe because collateral circulation is readily established. Ligature at B, in the event of destruction of the middle and inferior hemorrhoidal branches will cause gangrene of the upper rectum and lower sigmoid because of the absence of collateral circulation. (Taken from Hartman, ANNALS OF SURGERY.)

A child three years old was admitted to the hospital with a greatly distended abdomen. He had been obstinately constipated from his third month. The swollen belly was noticed when he was about seven months old. Fluoroscopic examination showed a huge sigmoid, which on operation resembled an adult stomach, the dilatation terminating at the recto-sigmoid junction. A rectal tube was inserted past this junction and a one-and-a-half inch longitudinal cut made over the seat of narrowing down to the mucous membrane which was allowed to prolapse.

Four months later the child was discharged from the hospital with no palpable or visible evidence of dilated sigmoid. Two months later he died of tuberculosis and was autopsied by Doctors Moffitt and Coover, who noted that the ascending colon, transverse colon and upper portion of the descending colon were large and about the size of those of an adult. The lower portion of the descending colon and sigmoid were more nearly normal, but the walls were very thick. The marks of the operation were scarcely visible.

The following case, typical of the adolescent and adult form of megacolon was apparently cured by an auto-dilatation of the recto-sigmoid sphincter.

Operative findings and pathological examinations of removed specimens show an enormous sigmoid with thick muscular walls, the dilatation ending abruptly at the recto-sigmoid junction. There are no other significant changes, hence the condition must be due to obstruction at this point, nor is there any way of accounting for this other than muscular spasm; rendered more effective by the sharp angulation and overfilling of the gut at this point.

The operation here recorded was based on this belief.

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An eighteen-year-old boy was admitted to the hospital, complaining of generalized abdominal pain, beginning on the left side which had lasted for two days and was accompanied by recurrent attacks of vomiting. He had not had a bowel movement for three days. The abdomen was greatly distended, rigid, tympanitic and tender over both lower quadrants. The white blood-cells numbered 13,000.

Operation revealed a large fecal impaction which was removed by combined intra-abdominal and rectal manipulations.

He was re-admitted to the hospital two years later in much the same condition as before; and again five months later. On both occasions the condition was relieved by repeated copious enemas which resulted in the passage of enormous amounts of fecal matter.

About two months after his last visit to the hospital his abdomen again became distended, but he obtained relief at home by large enemas which brought away about ten quarts of fecal matter, some of which was in large masses almost the size of a grape-fruit.

The patient was examined two years later and stated that he had been perfectly well since his last experience, had been working every day as an electrician and had a normal daily bowel movement. He was well developed, muscular, and there were no abnormal findings by abdominal and rectal examination. This patient had suffered from obstinate constipation and from bloated belly since early childhood. There were frequent periods when he would go without a bowel movement for a week or perhaps longer.

The probable explanation of cure is through the over-

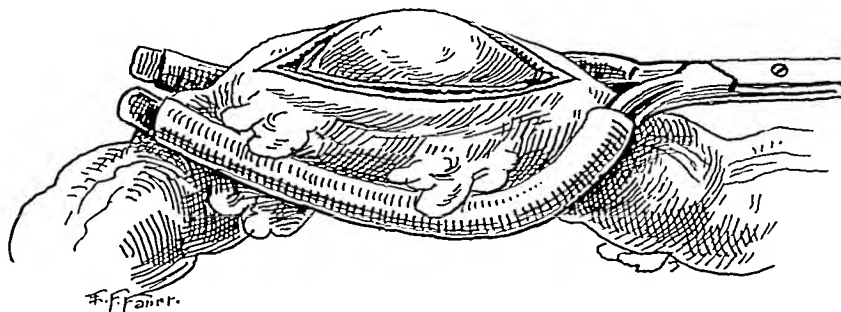


FIG. 5.—Longitudinal section of the bowel down to the mucosa which cuts across the circular fibres of the sphincter and allows the mucosa to bulge into the wound. (Adapted from the Rammstedt operation.)

stretching of the recto-sigmoid sphincter, by the passage through it of large fecalomas.

*Procedure of Treatment.*—For the ambulatory patient the best position is the knee-chest; for the case of Hirschsprung's disease, the knee-chest, left lateral or perineal position; for post-operative distention, the left lateral or perineal position.

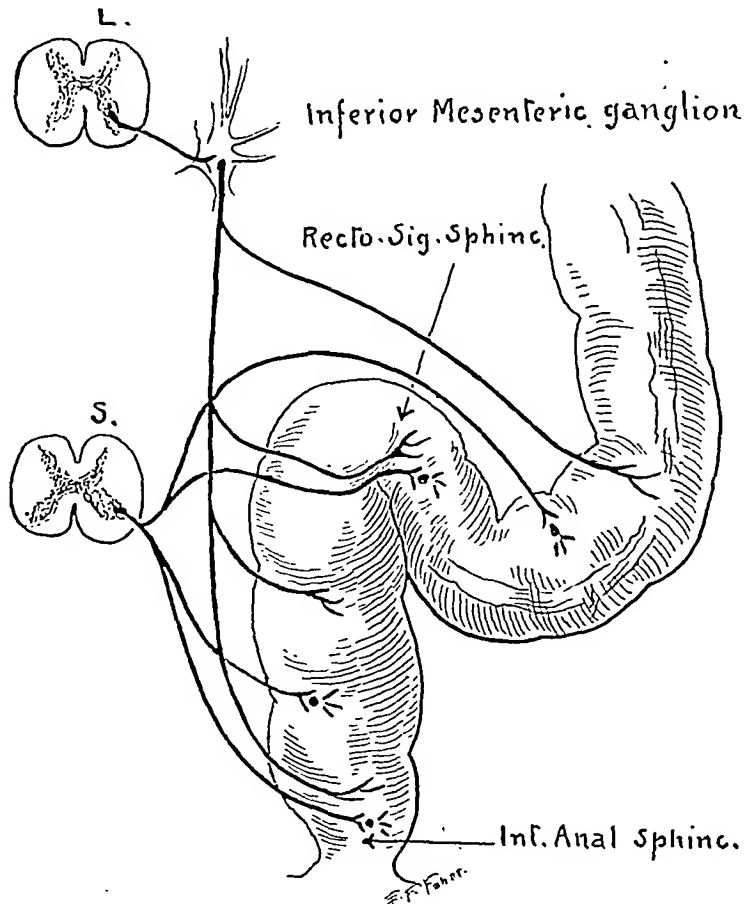


FIG. 4.—Nerve supply of lower sigmoid, rectum and recto-sigmoidal sphincter showing the double source of innervation from the sympathetic and para-sympathetic divisions.

With the patient in the proper position the proctoscope is passed with the aid of sight and air distention to the lower sigmoid. The dilating apparatus, well lubricated, is passed through the proctoscope and placed in the recto-sigmoid sphincter. The proctoscope is now withdrawn and the bag fully inflated by air under 160 mm. of mercury pressure. Overdistention of the bag is prevented by the silk covering. The dilatation is without pain and



FIG. 6.—X-ray photograph of dilating apparatus in position in the recto-sigmoidal region. The light shadow indicates the outline of the distended bag.

causes only slight discomfort in the lower abdomen. The apparatus is allowed to remain for ten to twenty minutes, is then deflated and withdrawn. For relief of post-operative distention a colon tube under guidance of a proctoscope is passed through the sphincter into the sigmoid and the distention thereby relieved. The anal sphincter also may be stretched by the dilating bag.

The apparatus consists of a proctoscope with the usual accessories, and an inflating bag. The dilating instrument consists of a rubber bag mounted on a colon tube in the lumen of which is

a flexible metal rod carrying a metal olive tip which facilitates passage of the instrument. The dilating rubber bag is covered by a silk bag which limits the degree of dilatation.

#### SUMMARY

In the absence of a demonstrable lesion, persistent tonus at the recto-sigmoid sphincter is the usual cause of sigmoidal stasis. This stasis may be expressed as in Hirschsprung's disease of the infant, as obstinate constipation and ultimate megalocolon in the adolescent or adult. It may further be expressed in the form of post-operative tympany, unrelieved by tube or enema.

The palliative treatment of sigmoidal stasis is based on measures designed to make or keep the bowel contents fluid, strengthen peristalsis, and relax the tonus of the sphincter muscle. Laxatives and purgatives given by the mouth and copious enemata keep or make the sigmoidal content soft or fluid



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and stimulate peristalsis. Belladonna derivatives relax spasm as does magnesium sulphate; the latter given in the form of an eight ounce enema of the saturated solution.

Chronic sigmoidal stasis with or without hypertrophy and dilatation of the gut may be cured by cross-cutting the recto-sigmoidal sphincter, allowing the mucosa to prolapse into this muscle wound without effort at plastic closure. Or the sphincter may be overstretched by means of a Plummer bag, or larger diameter than that used in the œsophagus, passed through a proctoscope.

Insofar as the colon is concerned post-operative tympany may be relieved by passing a colon tube into the sigmoid, guiding it through and past the recto-sigmoid sphincter by means of a proctoscope. Rivas has successfully passed such a tube, made soft by boiling, by the sense of touch, and has X-ray pictures to prove that it can be done.

# CHRONIC SYNOVIAL TUBERCULOSIS\*

BY CHARLES W. PEABODY, M.D.

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FROM THE ORTHOPEDIC DIVISION, DEPARTMENT OF SURGERY OF THE HENRY FORD HOSPITAL

THE conception of joint tuberculosis as a disease of bone in its essential pathology has found almost universal acceptance and is uniformly maintained in almost all pathological texts. Such very extensive studies as those of Fraser would almost seem to remove the subject from the field of dispute, as well as to further establish the proposition that invasion of the joint is invariably from a juxtachondral osseous focus, with synovial involvement, however widespread, a secondary phenomenon beside which bony lesions continue to progress as the essential pathology of the joint. Though less well supported by the evidence of pathological material, in some quarters a belief in frequent primary synovial invasion with only secondary involvement of osseous joint tissues still persists.

Quite as certainly in the minds of many clinicians there has persisted a conviction that both primary and chronic limitation of tuberculous pathology to the synovial and chondral tissues frequently occurs. In most instances this impression may have been based on an empirical foundation only; such as the observance over a considerable period of time of arthropathies believed tuberculous on various clinical grounds, which persistently failed to show by X-ray evidence of bone involvement, and finally recovered with preservation of both motion and function. Such instances have lacked confirmation of diagnosis by such positive evidence as microscopic section, and though occasionally supported by the guinea-pig inoculation test, seemed to have been mainly in smaller children where a bone focus cannot certainly be ruled out by X-ray and where occasionally cures can be expected under conservative treatment.

In the last few years several contributions to the literature, based on operative findings in early cases of joint tuberculosis, have emphasized definite synovial involvement without X-ray, gross, or microscopic evidence of a bony lesion. Rogers,<sup>†</sup> in 1922, reviewing such cases from the Clinic of the Massachusetts General Hospital, after emphasizing the outstanding pathological work of the past on bone tuberculosis, concluded that an alternative conception of primary synovial disease must also be accepted. In many instances his clinical evidence was not entirely conclusive; some of the cases were so early that a small bone focus might still not have developed to a degree where it could not be missed. The preponderance of discussion of this paper when presented before the American Orthopaedic Association in May of that year was distinctly against his proposition.

\* Presented at the Clinical (Central States) Orthopaedic Society, November 5, 1926.

† Rogers: *Journal Bone and Joint Surgery*, vol. xx, April, 1922, p. 679.

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The writer's own clinical impression from cases seen at the same Clinic in the years just preceding, had remained in accord with the classical conceptions of this disease, and had not been modified by subsequent clinical experience, until early in 1926, when by a strange coincidence there came to radical operation five cases of very long-standing joint disease in whom no osseous pathology could be found, though with indisputable microscopic evidence of synovial tuberculosis of long duration. It seemed that our previous convictions must be revised; and accordingly we noted with considerable gratification the conclusions in Smith's‡ comprehensive and scientific study of the pathology of joint tuberculosis as seen in Hibb's Clinic, New York, appearing in *Archives of Surgery* in May, 1926.

In this most excellent contribution a thorough review is made of important previous pathological investigations, and though a little of this work had been in favor of primary synovial disease, the weight of evidence had been strongly in favor of a bony pathology at the start. In the experience of that Clinic, on the contrary, most of the operated cases seemed to show synovial lesions only. Children predominated, and the adoption of the policy of early diagnosis by explora-



FIG. 1.—Case I. A. P., film of Röntgen examination, just prior to operation. Note excellent preservation of joint space and absence of decalcification. The roughened appearing lateral aspect of condyle of femur was examined particularly at operation and found to represent two irregular ridges, one at anterior and one at posterior margins of lateral surface where the latter joined the trochlear articular cartilage. There was no destruction of bone, but rather a proliferation process. Röntgenologist's diagnosis: Hypertrophic arthritis.

‡ Smith: *Archives of Surgery*, vol. xii, March, 1926, p. 740.

tion, with fusion following in the event of positive diagnosis of tuberculosis, had caused duration to be short in many. Still, Doctor Smith was able to collect a series of seventeen cases with an average duration of eighteen months, all proved at operation to have exclusively synovial lesions. Eight of the seventeen were under ten years of age and only three were adults. In two patients the duration was four years and in one five.

It had seemed to the writer that on such evidence as the latter—that is to say, adults with duration of years—that the brief for chronic synovial tuberculosis must mainly rest. When progressive synovial involvement has lasted in an individual for several years and no bone lesion has developed which can



FIG. 2.—Case I. Low power microphotograph of synovial section, showing on one hand fibrosis and on other extensive infiltration by round and wandering cells with many giant cells and in places areas of coalescence into large foreign body giant cells and typical tubercles.

be recognized either by X-ray or by the gross pathological findings of a radical operation, the additional suggested criterion of consecutive millimetre sections of the entire epiphysis of all the bones of the joint may reasonably be expected. Of course, argument may be raised as to the fallibility of evi-

dence of duration of disease, and the possibility that shortly before operation a tuberculous infection may have become engrafted in a rheumatoid or traumatic arthritis. It can only be said that in the recent experiences of the writer the microscopic study of the synovial pathology indicated a definitely chronic tuberculous process. We have frequently explored cases of comparatively short history and found limited and rather recent appearing synovial pathology. Although these were usually devoid of obvious osseous pathology, this evidence was considered of much less weight than that of the five cases to be described.

The five patients in this series were all adults who had had constant symptoms in the joint for from three to seven years. All had X-rays which we had considered negative for bony lesions, and all came to radical operation, excision and fusion being performed in three, and, for reasons which will appear below, synovectomy in two.

*From the many microphotographs and skiagraphs submitted by the author to illustrate the conditions found in these cases, certain ones only have been selected for reproduction as types.*

## CHRONIC SYNOVIAL TUBERCULOSIS

CASE I.—R. H., Case No. 71,671, a white male of twenty-six years of age, was registered in the Clinic in January, 1926, with the following history: Three years prior was kicked on the left knee by a cow, the knee at once becoming painful and swollen, but without complete disability and gradual amelioration of symptoms. Knee was never considered normal after this as some swelling soon recurred and intermittent periods of pain and considerable lameness, generally relieved by rest, and always free from pain at night and when not on his feet. Any sudden step or twist always brought an exacerbation, and a loss of complete extension had been gradually increasing since first injury. Three days prior to admission he had sustained an especially severe wrench with rather severe pain and increase in the swelling always present since first injury. Walking has been possible since only with marked limp and considerable discomfort. General condition had been good with no loss of weight or feverishness. Past history revealed nothing of importance save that he had had "chronic hip disease" in childhood and that arthrodesis had been performed on this hip at age of fifteen with no trouble since.

The physical examination generally revealed nothing of importance save bony ankylosis of the right hip in optimum position. (This hip had been operated by Doctor Hoke, of Atlanta, Ga.) The lungs were negative. The general nutrition was excellent. There was no local or general adenopathy. Temperature was normal. Routine blood Wassermann and urinalysis were negative. There was considerable constitutional reaction, definite increase in knee symptoms and elevation of temperature following subcutaneous injection of 0.5 mgm. of old tuberculin. Röntgenologist's report of X-rays of knee here shown follows: Antero-posterior and lateral view of the left knee. There is a distinct evidence of hypertrophic osteo-arthritis involving the bones comprising the knee-joint. There is, however, no definite evidence of bone injury.

Local examination on admission showed slight generalized enlargement of joint, moderate quadriceps atrophy, no atrophy of calf, no erythema or skin pigmentation; to palpation there was questionable local heat, moderate but quite definite synovial thickening and loss of elasticity, no ballottement of patella but possible fluctuation; tenderness was quite marked below patella, particularly at mesial aspect of joint line. Motion was executed readily though carefully with range from angles of 165 to 90. No crepitation audible or palpable was observed. Motion seemed to be checked by mechanical resistance rather than by spasm.

Pre-operative diagnosis of probable traumatic arthritis from internal derangement was held, but on account of the tuberculin reaction exploration was advised and performed on January 20, 1926. On diagnosis by microscope of tuberculosis, fusion of the knee was performed. That part of operative note including operative findings is quoted herewith:

"*Operation.*—Stockinette is clamped to the skin margins; all veins in subcutaneous tissue identified before division and tied. The quadriceps fascia and capsule are incised and a thick layer below it encountered; several deep plunges with knife made toward the centre of the joint in an effort to allow the escape of a portion of joint fluid for specimen, fails to penetrate the free cavity. The development upward finally reveals a free cavity in the quadriceps bursa. Thickened alar ligaments and apparently granulation tissue completely fills up the intercondylar space and the dissection has to go practically into the notch before free joint fluid is found. This in no way resembles joint fluid but more like very thin, old blood. Specimen obtained for diagnosis.

"*Pathology.*—As the dissection proceeds, presenting conditions are as follows: A very marked avascular thickening of the synovia in the region of the quadriceps bursa, a more vascular infiltration of the lining of the joint below, which is adherent to the edges of the condyles resembling pannus but much tougher and more fibrous than usually seen in tuberculosis; over the front of the condyles along their ridges there is no evidence of bone necrosis but on the contrary of bony proliferation. This pannus, adherent to the cartilaginous surface of the intercondylar region, solidly fills up the notch and has overgrown the cartilaginous surface of the condyles for a little way in from either side."

In addition to resections for fusion the joint was completely luxated and synovial

membrane carefully dissected completely from both anterior and posterior compartments, but everywhere exposing intact cortical bone. The bone sections from femur, patella, and tibia revealed no areas of central necrosis.

Following is report from Pathological Department on hardened sections:

"The specimen consists of several thin pieces of cancellous bone removed from knee-joint. Some are covered with the joint cartilage and can be identified as those of tibia. The cartilage surfaces are finely roughened, the synovial membrane is apparently replaced by pale brown, soft, fringy overgrowth. In the bone no macroscopic changes are seen.

Sections show the synovia infiltrated throughout by round and wandering cells with many whirls of epithelioid cells scattered throughout. In the centre of most of these whirls we see typical foreign body giant cells so that they form typical tubercles. The

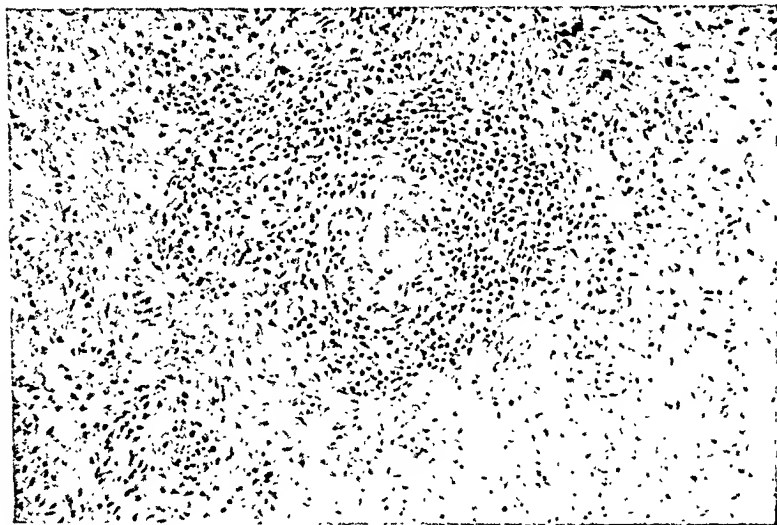


FIG. 3.—Case II. One of many typical tubercles found in synovial membrane.

lesion seems to be of the productive type since no destruction or necrosis is found. Diagnosis: Tuberculosis. The patient made an eventful convalescence, returning to his work as electrician three months after operation. Final examination nine months after operation showed bony ankylosis in position of 15 degrees flexion, no varus or valgus.

CASE II.—J. V.,

Case No. 70,187, white male, aged thirty-one, registered in the clinic in November, 1925, with following history: Seven years prior with no definitely recalled injury began to limp with pain at inner side of knee. Shortly after was in bed six weeks with pneumonia and pleurisy and at end of that time knee seemed to have recovered. In a few weeks began to be occasionally a little lame after exertion and sometimes accompanied by moderate swelling. Five years prior bumped knee slightly with rapid development of pain, swelling and limitation of motion. Plaster cast was worn for one month and followed by physiotherapy with considerable improvement though swelling never entirely left, knee never became quite straight nor could it be bent beyond a right angle without pain. Two years prior there was another acute exacerbation of symptoms after moderate strain and ever since these have been recurring with increasing frequency and with progressive limitation of range of movement after each. Lately has been using cane with some improvement in symptoms. Has never any pain at night or while off his feet, and no feverishness or chills associated with exacerbations. General health has been good, no loss of weight, present weight being within a few pounds of normal. Has regularly kept up his profession as attorney.

General examination showed nothing of importance. Chest was negative and there was no adenopathy, general or local. Examination of the knee showed marked enlargement but this in main involved the mesial pouch of quadriceps bursa and with leg held slightly externally rotated at knee, gave an appearance of considerable valgus. There was marked quadriceps atrophy but no atrophy of calf. There was no erythema but a rather definite yellowish tinge to skin. Local heat was questionable, but to palpation there was definite fluctuation though the patella was not floating. There was slight generalized synovial thickening. Range of motion was between 165 and 100 degrees

## CHRONIC SYNOVIAL TUBERCULOSIS

accompanied by a grinding sensation. There was marked excess lateral mobility but considerable pain if any manipulation was attempted.

Temperature was normal. Blood Wassermann and routine urinalysis was negative.

X-rays of knees, shown here, indicated some absorption of joint cartilage and thickening of soft parts but no erosion, defect or localized increased radiability of bones. Röntgenologist's diagnosis—arthritis.

Tentative diagnosis of chronic hypertrophic synovitis from internal derangement was held but for some apparently instinctive reason the writer advised preliminary exploration under local.

Operation was performed February 13, 1926. The exploratory incision revealed extensive synovial pathology with immediate report of tuberculosis on frozen section. Arthrodesis was at once recommended and vigorously urged but patient steadfastly refused to consider any operative procedure designed to stiffen the joint though he would agree to any other intervention with fusion to fall back on later if necessary. Accordingly a complete synovectomy was performed. The incision was widely extended after the manner of Timbul-Fisher, the entire ends of tibia and fibula delivered through the incision and both posterior and anterior compartments thoroughly explored and cleaned out. Throughout the pathology was found confined to synovia and cartilage and no break in integrity of cortex of either bone was revealed. The operator's dictation was as follows:

*Pathology.*—A most interesting and unusual pathology is revealed by the extensive opening of the joint obtained through the long incision. Everywhere the synovial membrane is thickened, œdematous, grayish, and less injection of blood-vessels than usually seen. Almost everywhere, except in the quadriceps bursa, the endothelial lining has been replaced by a low-grade granulation tissue, typically pannus in appearance, but with the impression of decreased vascularity. In the notch, however, the congestion is more active and the granulation tissue more typically tuberculous. On the other hand, the alar ligaments are extremely large, are perfect in their morphology and otherwise differ only in a lemon tinge instead of the golden yellow. The trochlear surfaces are markedly encroached upon both sides of the notch by pannus formation destroying the cartilage from the borders centrally. The same is true with the articular surface of the patella, the peripheral 50 per cent. being eroded. The erosion is inconsiderable on the tibial condyles but the internal meniscus is completely absent or at the most only a fibrous strand adherent to the capsule, represents this former structure. The external meniscus is completely detached from the tibia but adherent to the capsule and is markedly atrophied. Part of the quadriceps bursa was obliterated. Extreme bulging at the antromedial aspect of the knee, which was thought to be a hernia of the synovial membrane and capsule from hydrops, turns out otherwise. There is decreased fluid in the joint and there is found at the point of this bulging an extra-capsular pocket which seems to be caused by an old obliterated sinus of the quadriceps bursa. This pocket is about as large as a small lemon, at the inner side of the knee it communicates with a larger one which extends up along the medial aspect of the femur between the adductor and quadriceps groups half way to the hip. This dead space is filled with semifluid mass in which free fluid is very small in amount and is oily rather than pussy, but the bulk of the contents consists of short worm-like pieces of pale yellow jelly-like material not altogether different from an early fat necrosis. It slightly resembles, but not very closely, the detritus seen in cold abscess, extra-articular, of other joints. Enough of this stuff is milked out to make up a bulk of about one pint. During the course of the radical dissection it became possible to explore the articular surface everywhere with the single exception of the most posterior aspect of the condyles. Nowhere was any bone necrosis observed and the pannus when scraped away reveals hard cortical bone."

Convalescence from operation was satisfactory enough in view of conditions, though as expected pain, sensitiveness and muscle spasm made impossible any early movement that would have made for recovery of mobility in the knee. Temperature was slightly

elevated in first week but normal thereafter. After about ten days wound broke down in centre with sinus formation discharging typical tuberculous material similar to that removed at operation. This persisted for about eight weeks. Patient became ambulatory in cast twenty-five days after operation. He has continued since in a leather case, quite

content to accept a fixed knee and impatiently awaiting a safe time to have arthrodesis performed. Nine months post-operative X-ray showed no evidence of spontaneous fusion and there was found about 15 degrees motion in knee on examination. Pathological report follows:

"Fusion performed December 17, 1926. Operation showed ankylosis of patella, fibrous obliteration of bursæ and most of joint space, nearly complete erosion of cartilage by pannus ingrowth, most of external meniscus absorbed and cortex in outer portion of external tibial surface eroded over an area one inch in diameter. Bone was necrotic through cone-shaped area three-eighths inch deep beneath this with typical caseation. To this observer it was more suggestive of penetration of bone from joint than of vice versa. Otherwise the sectioned sub-cortical bone was normal. A small collection of the pus was found in thigh at top of old quadriceps bursa.

"Specimen consists of a handful of soft tissue consisting of muscle, fat, synovial membrane and granulation tissue; jelly-like, fatty, yellowish-gray masses; bit of indurated grayish-yellow fat with a small area of more reddish, friable granulation tissue along one margin.

"Section taken from thickened synovial fringes show the same infiltrated throughout by round and wandering cells with many whirls of epithelioid cells. These whirls of epithelioid cells often have giant cells or areas of dirty blue-staining necrosis at the centre, thus forming typical tubercles.

"Impression: Tuberculosis."



FIG. 4.—Case III. Röntgen examination pre-operative, three years after onset of symptoms. A questionable area at postero-mesial aspect of ulna was investigated and found to show atrophy only. Lateral view of this elbow showed joint surfaces very clearly, but has been lost from files.



## CHRONIC SYNOVIAL TUBERCULOSIS

CASE III.—L. M., Case No. 69,259, colored woman, twenty-six years of age, occupation janitress.

*History.*—Three years prior to operation with injury recalled, began to have pain and soreness in left elbow after use, clearing after a week of rest. There were intermittent symptoms ever since, increasing in frequency to three or four weeks and requiring longer period of rest for relief. Lately swelling and limitation of extension had developed. Never any pain except when using elbow and for short time after, until lately, when after a day's washing it would become too painful to use the next day.

*Examination.*—Moderate enlargement of the joint but no deformity; no local heat; definite synovial thickening; moderate tenderness; no crepitation; range of motion from 120 to 75 with muscle protection. General examination showed a well-nourished and slightly obese female with findings of chronic tonsillitis and oral sepsis but otherwise essentially negative.

Neurological survey revealed nothing suggestive of central nervous system disease. Temperature, 99; blood Wassermann—four plus to Kolmar antigens.

X-rays were not as clear as could be desired and apparently indicated considerable increase in density of soft parts, but there was no evidence of proliferative activity of bones involved and no areas of decreased

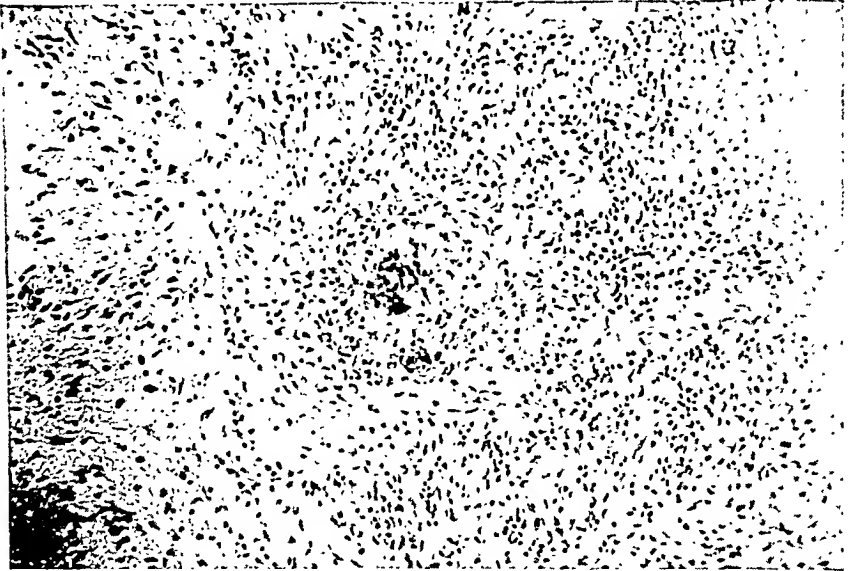


FIG. 5.—Case III. Synovial section showing large foreign body giant cell and typical tubercle in midst of round-cell infiltration.

density or of fragmentation. Considerable loss of joint space was inferred and some areas of erosion of joint surface. See operative findings in this regard.

The diagnosis most favored was luetic arthritis; however, subcutaneous old tuberculin was given, with a markedly positive constitutional and local joint reaction. Accordingly exploration for diagnostic section was deemed indicated, advised and accepted. On November 15, 1925, under local anæsthesia, a piece of synovia was excised for study. In meantime régime of antiluetic treatment was instituted.

The immediate frozen section report was rather indefinite, no typical tubercles being found. Later hardened sections revealed scattered but definite tubercles and giant cells on more extensive search. Accordingly arthrodesis of elbow was advised the patient.

Operation for this was performed on April 2, 1926. The unusual nature led to a very detailed dictation at that time. Following excerpt covers pathology found present of note:

*Pathology.*—Present and subsequent dissection seems to reveal a pathological process confined almost entirely to the synovial membrane. This is tremendously thickened throughout, obliterating all the joint spaces; being in the main pale, œdematous, but in places were low-grade granulation tissue and increased vascularity. At the joint surface, pannus formation has extensively eroded the humeral cartilage, but less so on the ulnar and very little on the radius, subsequent bone dissection failing to strike any point of bone pathology whatever. Normal cancellous bone being everywhere exposed.

The impression gained from examination of a very active and extensive synovial process seems to indicate more than usual care in removal of the pathological tissues in

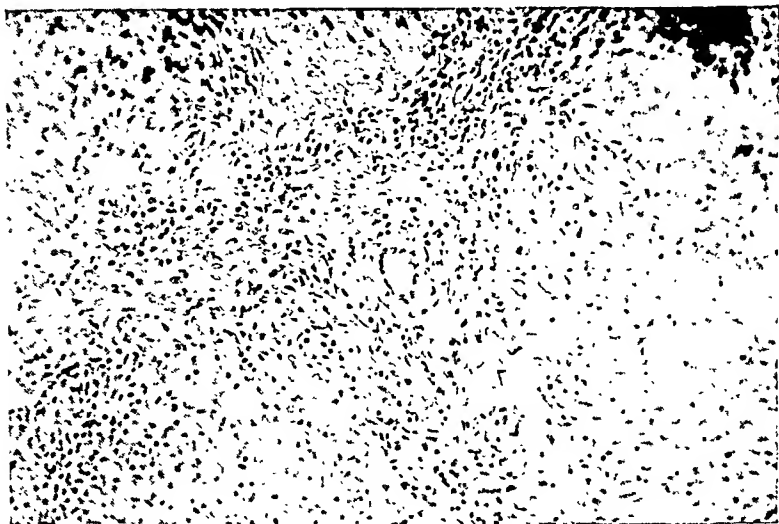
the joint and accordingly a complete synovectomy is done. The lateral ligaments are incised adequately to allow luxation in both directions of the arm and forearm. Line of cleavage is easily found in the deep capsule of triceps bursa and following this round, the thickened oedematous synovia is completely removed from this bursa, from the sides of the joint, from the coronoid bursa and from that surrounding the head of the radius. It is possible to reach every recess and quite certain that complete synovectomy has been done. Excision and internal fixation by beef bone nails was performed."

"*Pathological Report.*—The specimen consists of about one dozen pieces and chips of bone and about 100 grams of ragged grayish bits and pieces of muscle tissue and ligaments. The bone fragments show here and there cartilaginous surfaces some of which are eroded. Some of the soft tissues are pale gray and suggestive of some

granulomatous process.

"Sections show areas of hemorrhage surrounded by granulation tissue throughout which we see whirls of epithelioid cells often with typical giant cells at the centre forming tubercles. In other areas we see large, pink staining, neurotic masses. "Diagnosis: Tuberculosis."

Immediate convalescence was satisfactory but the sinuses



† FIG. 6.—Case IV. Synovial section showing early tubercle formation.

discharged intermittently for several months. At end of six months there was clinically and by X-ray bony ankylosis, and patient was again doing her work as janitress.

CASE IV.—B. D., No. 36,347, white male, age twenty-three years, struck right elbow in October, 1922 (about three and one-half years prior to operation), on an iron beam with immediate pain, and disability followed by slight residual soreness and periodic exacerbations with minor injury. Thirteen months subsequent to onset was examined in this clinic with findings of moderate hydrops of joint and moderate limitation by muscular protection, 160 to 60°. Aspiration advised but patient did not return. Tonsillectomy, later performed without appreciable benefit. Claims he was benefited by chiropractor and returned to work, but symptoms always increased until he laid off for about a week, when he would feel much better. Said swelling was negligible until last six or eight months when it increased with exacerbations and remained more swollen after each. One month before operation quit work on account of increasing pain, but this had almost cleared up at admission.

Physical findings before operation showed a healthy looking young fellow, well developed and nourished, without adenopathy, local or general, and essentially negative physical findings throughout save in the right elbow. The latter was visibly enlarged, particularly in the region of the triceps bursa. No erythema or skin discoloration was evident. To palpation there was no local heat but definite fluctuation, and also a hard resistance back of the condyles, and sensation of generalized synovial thickening. There was little or no tenderness to palpation, there was no relaxation of joint and no crepitation. Extension and flexion were each limited to 50 per cent. of normal, but were not accompanied by muscle spasm or obvious protection.

First X-ray examination on this patient was obtained thirteen months after onset

## CHRONIC SYNOVIAL TUBERCULOSIS

of symptoms and beyond a slight increased density of soft parts absolutely no pathology could be made out in very clear plates. Films made just prior to operation, three and one-half years after onset, differed only in further evidence of soft part swelling and suggested rarefaction at one side of olecranon. X-ray diagnosis both sets were infective arthritis.

Aspiration of elbow was performed prior to operation and guinea-pig inoculation carried out. As tuberculin test was typically positive both in constitutional and joint reaction, guinea-pig test was not awaited, operation being advised for arthrodesis or synovectomy depending on pathology present. However, it was interesting to note that this pig was negative at eight weeks and that another pig inoculated from operation material died at seven and a half weeks with no evidence of tuberculosis.

Operation was performed January 30, 1926, the joint being exposed through a very long posterior incision allowing wide retraction similar to that in the knee. This allowed a quite complete synovectomy, this layer being shelled from all parts of joint except anterior ulnar compartment, and a bony exploration of the only area at all suspicious in X-ray. On account of the unusual character of case the operation notes dictated at that time were made unusually detailed, and where bearing on pathology, are quoted herewith verbatim:

"As the distended triiceps bursa is punctured there

escapes joint fluid in considerable amount and normal in appearance, except for increased viscosity. With the escape of joint fluid there delivers itself from the aperture a large mass of loose fibrous material which has a somewhat granular or streaked surface, is irregularly quadrilateral about  $\frac{3}{4} \times 1\frac{1}{4}$  inches, thins out at its edges, but is about  $\frac{3}{8}$  inch thick at its middle. It can be expressed completely and seems to have been free in the bursa. An elliptical incision of the synovia adjoining the incision is made. The synovia looks avascular and does not suggest inflammation. These two specimens are given to the



FIG. 7.—Case V. Lateral view, original of which clearly delineates the entire curve of femoral condyles in spite of the zone of increased radiability at the cortex.

pathologist for frozen section report. He returns the report of round-cell infiltration, but no definite evidence of tuberculosis or active inflammatory disease. Accordingly the triceps bursa is completely cleaned of all its synovial lining, removing all the tags.

Further inspection of the joint revealed a few smaller masses of fibrous material similar in type to the one first expressed which were also free. The bursa had been very much distended, obviously only partially with joint fluid and principally with this fibrous mass. Others were seen hanging from the surface of the synovial lining, and a mass of this material solidly filled up the olecranon fossa where it was adherent and where it had obviously provided mechanical limitation to extension.

X-rays had, show an area suggesting necrosis in the posterior mesial corner of the ulna and it is felt inadvisable to leave this uninvestigated. The capsule is accordingly cut away from near the base of the olecranon and back of the ulna, and stripped off



FIG. 8.—Case V. Low power of a section of synovia showing conglomerate tubercles, practically no normal tissue being seen.

enough from the joint line to expose the cortex of the ulna over this area. The cortex is drilled with a knife revealing apparently normal, if somewhat atrophic, cancellous bone. A small curette is placed through this opening, cautiously exploring without locating anything suggesting caseation of pus."

The operator's impression of chronic hypertrophic or villous synovitis with tendency toward that pathology styled osteochondromatosis by Henderson seemed to be sustained by the frozen section report. Accordingly it was with greatest surprise that the report of the fixed sections was received a few days later. The report follows:

"Sections show the synovia infiltrated throughout by round and wandering cells. In places there are typical whirls of epithelioid cells with giant cells scattered throughout or at the centre, forming typical tubercles. In other areas we see larger collections of epithelioid cells with areas of homogeneous blue-staining material at the centre."

Although the incision healed per primam without local inflammatory signs, the temperature was up to 102° for the first two days, being normal on the fourth day. The elbow was extremely sensitive and following final pathological report policy of early movement was changed to immobilization, kept up for two months, and very gradual motion encouraged. At this time the elbow showed no swelling or tenderness, and had

developed a range of  $45^{\circ}$ , but checked at this point by pain. Patient was not willing to follow advice on continuing the limited motion brace and dropped out from observation. We obtained a report six months post-operative from another röntgenologist who reported still no evidence of bony pathology.

CASE V.—R. E., Case No. 87,584, a Scotch housewife of fifty-two, registered in the Clinic on January 8, 1927, complaining of lameness and disability in the right knee of two years' duration. The onset had been moderately rapid but without any injury recalled. First symptom moderate pain on use, followed by increasing lameness and swelling. After a few months marked swelling developed with pain becoming constant and preventing any movement. Knee was lanced with discharge of thin yellowish fluid lasting for one month only. Condition improved following this and she could resume most of her household duties with an incomplete range of motion. Occasional exacerbations responded to rest till six months previous when swelling rapidly recurred with complete restriction of motion from pain. Knee was lanced again and drained for six weeks. Subjectively there was improvement and she could be around on the leg but with joint motion about half normal. This was painful, however, had become progressively more so till now she could permit no movement at all.

There was a past history of a tuberculous finger removed at age of four. Although always spare and never weighing over 100 pounds, had led an active life and borne nine children; in the last few years she had weighed about 75 pounds, present weight being 70.

Physical examination: A rather anæmic looking and distinctly frail but otherwise well-preserved woman in no obvious discomfort. The right leg was maintained with knee extended. There was marked atrophy of thigh and calf but actual enlargement of knee was slight. There was definite fulness below and around the patella. There was no redness but slight local heat. Periarticular tissues were definitely thickened but there was no fluid wave. While tenderness to pressure was slight, only a few degrees of movement of the joint could be obtained on account of pain and muscle spasm. There was a small healed scar at the outer side of the patella.

General examination revealed unimportant findings save for evidence of old fibroid phthisis in the right upper chest and moderate myocardial weakness (EKG) with an indefinite systolic murmur and presystolic thrill. Blood-pressure was 90/56.

Blood Wassermann test was negative and urinalysis showed normal findings. White blood count was normal and reds four million. Temperature and pulse rate normal.

X-ray films of chest confirmed, clinical impression with additional evidence of some infiltration in the other apex. X-rays of knee showed some general osteoporosis and rather marked increased radiability of the cortical portions of the articular areas, but no loss of joint space or definite evidence of erosion of joint surface and no point in either bone suggestive of focal necrosis.

Supported by recent previous experiences, the original clinical diagnosis was tuberculous synovitis, operation advised and patient admitted to hospital for this. The next day she became very hoarse with a definite laryngitis and temperature over 100. A period of observation was decided upon and plaster fixation was applied to the knee. At the end of a week temperature had become normal and voice had largely returned. In this period the Nose and Throat Division had done a direct laryngoscopy with impression of early laryngeal tuberculosis. A course of ephederin treatment had raised blood-pressure to a systolic average around 110. The knee had become entirely comfortable at the end of the second week. Operation was performed under spinal anæsthesia, including a biopsy of synovial tissue followed by routine arthrodesis. That part of the operative note describing the pathology is quoted herewith:

Pathology: "The knee when exposed shows cartilaginous surfaces everywhere normal looking and intact save for one point about one mm. in diameter at the front of

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§ This last case has been added to the series reported before the Clinic Orthopædic Society in November, 1926.

the lateral condyle, where there is a small defect with a fresh red bony surface beneath and it quite definitely suggests an accidental injury during the biopsy. The synovial membrane is hypertrophied throughout and at the sides of the joint sac, in the posterior compartment, and in the notch there is a distinctly pathological looking membrane and granulation tissue. No granulation tissue encroaches on, or has affected the cartilaginous surface. Bone sections reveal no osseous pathology."

Pathological report: "The specimen consists of right knee. The joint parts of femur and tibia are cut in thin slices. The cartilaginous joint surfaces are smooth and pale. The synovial fringes are thickened by fatty and fibrous changes and their surfaces show everywhere granular and nodular whitish gray deposits. On cut the bony parts are rather fatty and cancellous. The thickened synovia cuts like scar tissue and shows fibrosis.

Microscopic: Section A shows the tissue removed to be infiltrated throughout by round and wandering cells and whirls of epithelioid cells often with giant-cells at the centre. The latter form typical tubercles.

Section B through this tissue shows the same almost replaced by whirls of epithelioid cells which in many cases show giant-cells at the centre, thus forming typical tubercles, single and conglomerate. In addition to the tubercles there is intense round and wandering cell infiltration throughout the tissue.

Diagnosis: Tuberculosis (synovial)."

Post-operative convalescence was ideal, entirely unaccompanied by any shock, and although temperature was elevated again for the first week, no pain was complained of after the second day. Wound healed kindly and general condition seemed excellent. Patient was discharged in cast at the end of two weeks, and subsequently was given a leather knee case, which she is still wearing.

#### SUMMARY

Five patients suffering from a chronic joint disorder of from two to seven years' duration presented physical findings inconsistent with those commonly looked for in established joint tuberculosis, and X-ray films negative for bone destruction or absorption. All came to radical operation widely exposing the joint and revealing the pathology of long-standing tuberculosis throughout the synovial membrane unaccompanied by any lesion of bone. Four were adults between ages of twenty-three and thirty-one in excellent general health and free from constitutional stigmata of tuberculosis. In none did a pre-operative diagnosis of joint tuberculosis seem to have clinical support. §

#### CONCLUSIONS

Chronic slowly progressing tuberculous arthritis of exclusively synovial pathology, though not usual, is a definite clinical entity to be kept in mind in differential diagnosis. In chronic monoarticular joint disease biopsy of synovial membrane may frequently be necessary for diagnosis.

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§ Since submission of this paper two patients have come to exploratory and subsequently radical operation, in whom a joint disturbance of from twelve to fifteen months had been present, X-ray examination was negative for bony involvement, joint surfaces were completely preserved in integrity and extensive tuberculous involvement of the synovial membrane was present.

# THE PATHOGENESIS AND TREATMENT OF ACUTE EPIPHYSITIS

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A FORM of acute osteomyelitis occurs in which the focus of infection centres in an epiphysis. Necessarily this is found to occur while the epiphyseal cartilage still exists; and, most frequently, it affects children and infants. Commonly this is called acute epiphysitis. Acute epiphysitis occurs very frequently; its essential nature is often hidden in the gross lesion, and in complicating factors; it has a large morbidity and a high mortality; and, in those who recover, wrong principles in treatment frequently are followed by disabilities of various kinds which form great handicaps to the function of the joint and of the limb. The purpose of this communication is an explanation of the essential mechanism of acute epiphysitis; of the pathogenesis whereby the full development of such foci of infection are accomplished; of the clinical manifestations which accompany these changes; of the ways in which complications especially joint complications develop and the character and form of the latter; of the effects the latter have in changing the dominant characteristics of the clinical picture; and of the principles according to which treatment should be undertaken.

The present discussion includes only those cases of acute epiphysitis caused by the ordinary forms of pyogenic bacteria. Cases due to infection by tubercle bacilli, syphilitic virus, or actinomyces are not included; nor any case originating in such obscure pathology as that associated with thromboangitis obliterans, the various forms of vascular gangrene, Volkmann's contracture, etc.; nor those cases customarily described under the terms, osteochondritis deformans juvenalis coxæ (Legg's disease—Perthes' disease), Osgood-Schlatter's disease, Kohler's disease, etc.

The etiological causes of acute epiphysitis are no different than those which are found in the ordinary cases of acute osteomyelitis in which the lesion is centred in the diaphysis of the bone; they include infection by staphylococci, streptococci, etc. Although some of the text-books speak of cases of acute epiphysitis which follow the infectious diseases such as typhus and typhoid fevers, etc. I have personally never seen such a sequence of events and from a consideration of all of the available facts I am convinced that acute epiphysitis following such infections is caused by similar bacteria, is of extreme rarity, and is possibly a coincidence.

Exactly as in cases of acute osteomyelitis cases of acute epiphysitis find their origins in and form lesions—fixation points—of states of bacteriæmia



or general blood infection.\* The mechanisms whereby these general states of infection find their inceptions and develop subsequently, were extensively discussed in previous communications and will only be summarized here as follows:

States of bacteriæmia and general blood infection are derived from foci of infection which develop on a surface of the body—external skin, mucous membranes lining the alimentary, genito-urinary, pulmonary, etc., tracts, etc. The exact mechanism of their production is found in the presence of a thrombo-phlebitis in which bacteria are present and in which the continued growth of the latter results in a penetration of the substance of the clot until

\* The old terminology used in association with the phenomena of bacterial infection and including such terms as sepsis, septicæmia, sepræmia, pyæmia, etc., will not be employed in this communication. The reasons for this were described in a previous communication and a simplified terminology was suggested. In accordance with the latter only the following terms—infection, bacteriæmia and general blood infection will be employed in this communication with the following definitions:

1. The term "infection" will be used as a generic one and will include all of the phenomena of a bacterial attack on tissue, organ or the entire body. The various kinds of infection will naturally be described in accordance with the tissue, organ, or part of the body involved, and in accordance with the organism, or organisms encountered; thus saprophytic infection of the uterus, staphylococcus infection of the skin or streptococcic infection of the liver, etc. When no other modifying term is employed it is to be assumed that cultivations of the peripheral blood taken during life are sterile. The differentiation commonly made between local and general infection theoretically does not exist and the terminology is one more of convenience than of accuracy. Local infections must necessarily involve some degree of general constitutional reaction and general infections must necessarily find their beginnings in, or be associated with a local focus of infection. As far as possible this differentiation will be avoided or made clear in the text whenever it must be used.

2. The term "bacteriæmia" will, also, be used in a generic sense to indicate any condition in which living bacteria can be cultivated from the peripheral blood during life. The various kinds of bacteriæmia will, also, naturally be described in accordance with the organism found: thus, staphylococcus bacteriæmia, streptococcus bacteriæmia, etc.

3. The term "general blood infection" will indicate a subgroup of the generic term "bacteriæmia" and a distinction will be made between the terms "bacteriæmia" and "general blood infection" on the following basis: The term bacteriæmia is meant to imply a condition in which the organisms demonstrable in the circulating blood by the usual cultural methods are derived from a local lesion somewhere in the body, are usually small in number and the faculty of destroying the circulating bacteria is more or less retained by the appropriate antibodies of the blood. The term "general blood infection" is meant to imply a condition in which in addition to the foregoing a multiplication of the bacteria takes place in the circulation and the faculty of destroying the circulating bacteria is more or less lost by the appropriate antibodies of the blood.

Under appropriate circumstances both of these groups of terms will be employed together: Thus staphylococcus infection of the skin with staphylococcus bacteriæmia or general blood infection. The character of the local lesion in the complete development of any individual infection is best described by the use of the terms "primary," or "secondary" ("metastatic," "subsidiary"): thus, "primary streptococcus infection of the tonsil with secondary streptococcus infection of the appendix," etc., the absence of any descriptive bacteriæmia indicating that a cultivation of the peripheral blood made during the course of the illness was sterile.



the organisms reach the surface of the thrombus in direct contact with the circulating blood: the bacteria demonstrable in the cultivations of the peripheral blood are these same organisms which are carried away from the surface of the clot either as isolated organisms or as clumps of organisms by the force of the circulating blood. Pieces of infected blood clot also become broken away and dislodged from the mother clot and the free fragments when arrested in the capillary circulation of some nearby or distant tissue or structure of the body form "fixation points" around which secondary, subsidiary or metastatic foci of infection are developed. Such subsidiary foci develop in bones, joints, the intramuscular fascial planes, the viscera, etc.

Environmental factors and conditions determine in a similar way the localization of a focus of osteomyelitis and of acute epiphysitis, one of its varieties. In actual disease the contributory local factors which determine the fixation point of a focus of infection under the clinical manifestations of an acute epiphysitis must necessarily exist in the epiphysis itself and in its vascular structure. As in acute osteomyelitis the two important local factors are (1) the exhibition of some form of trauma—physical and mechanical trauma, chemical trauma, etc.; and (2) the anatomical characteristics of the local circulatory network and the physics of the local blood circulation at the given moment. Each of these two factors are of equal importance in the localization of a fixation point in the immediate environment of an epiphysis.

Cases in which the trauma preceding the manifestations of an acute epiphysitis is a distinct physical entity are of common experience and are met in almost daily practice. The degree of the trauma and its extent varies all the way down to minor grades until it is so slight as to be unrecognizable. The resulting physical basis for the development of a subsidiary focus of infection is a gross or microscopic hæmatoma associated with blocking of the circulation at one or more points because of gross or microscopic tearing of vessels; at the point where the continuity of the circulation is thus broken, the arresting of blood and bacterial emboli becomes likely; this is the point of fixation in and around which a focus of infection develops.

Other forms of trauma occur; these have been fully discussed on previous occasions. The discussion will not be repeated here because of the relative unimportance of other forms of trauma when compared with physical trauma.

Under any circumstance a fixation point is formed by the arresting of a thrombus-embolus at some point of the vascular network. The actual point frequently depends more upon chance than upon anything else and is decided by the physics of the local epiphyseal circulation at the given moment in accordance with the facts previously outlined. Infection comes about because of the presence of living bacteria in the arrested thrombus-embolus, or by the attraction of organisms carried to it in the free circulation. Various pathological pictures result depending upon the size of the plugged vessel, the relative position of the plug in the vascular network, the powers of vascular anastomosis, etc., in conjunction with the character, type, virulence, etc., of the organisms giving rise to the infection.

A typical specimen of the circulation in a long bone is shown in Fig. 1. There is a separate circulation for the diaphysis and for the epiphysis. The circulation of the epiphysis enters most often at more than one point, among which oftentimes a main channel can be distinguished. The epiphyses obtain their blood supply from the periosteal network of arteries, large branches of which perforate the thin layer of compact tissue on their exterior, and are

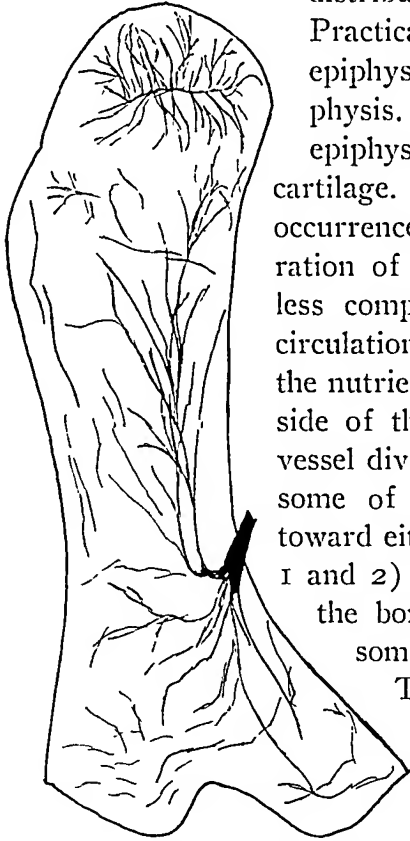


FIG. 1.—Typical blood supply of any long bone. Taken from E. Lexer, Kuliga and Turck. Note the diaphyseal and epiphyseal circulations and the relative avascular area between. Note the attempt at the formation of a main channel in the epiphyses. This and the following are injection specimens.

distributed throughout the spongy cancellous tissue.† Practically the whole of the blood supply of the epiphysis is therefore independent of that of the diaphysis. Only one or two minute vessels pass into the epiphysis from the diaphysis through the conjugal cartilage. This accounts for the comparatively infrequent occurrence of necrosis of the epiphysis in traumatic separation of the epiphysis even when the latter is more or less completely displaced from off the diaphysis. The circulation of the diaphysis is derived from a large vessel, the nutrient artery of the bone which enters a little to one side of the centre of the shaft. Immediately, the main vessel divides into a number of large branches which pass, some of them upward and some of them downward toward either end of the shaft. A diffuse network (Figs. 1 and 2) is formed which supplies the entire interior of the bone and its medullary cavity. Toward the end

some of the main branches become end vessels. There is a free anastomosis between the plexus of vessels thus established and the vessels derived from the periosteum through Sharpey's fibres. In a growing bone, with the epiphyseal cartilage still present, there is little direct anastomosis between epiphysis and diaphysis and a relative avascular area results; in a fully grown bone there is an extensive anastomosis between the two.

The avascular area in a growing bone results from the termination of the epiphyseal and diaphyseal circulations within a short distance of the epiphyseal line. The terminal vascular network on either side is made up of vascular loops which result from the free and extensive anastomosis, (1) on the epiphyseal side, of the various vessels and their branchings which supply the bone structure of the epiphysis, and (2) on the diaphyseal side, of the free and extensive anastomosis of the numerous terminal branchings of the nutrient artery of the diaphysis of the bone near the avascular area; on the diaphyseal

† In the hip-joint the blood supply of the epiphysis which forms the head of the femur is derived from a single vessel which passes to it in the ligamentum teres: the vessel is the terminal part of the transverse branch of the internal circumflex artery, a derivative of the deep profunda branch of the femoral artery. (Vide Fig. 2.)

## PATHOGENESIS AND TREATMENT OF ACUTE EPIPHYSITIS

side of the conjugate cartilage end vessels are also present. Nutrition in the avascular area is a lymphatic affair.

This is the physical anatomical structure and the functional physiological basis upon which the local lesion of an acute epiphysitis is built. For obvious reasons the essential nature of the pathological lesion in acute epiphysitis is the exact counterpart of that of acute osteomyelitis in the diaphysis of a bone and any slight peculiarities are due to differences in arrangement of the vascular tree in the epiphysis as opposed to that in the diaphysis. The dominant characteristics of the pathological picture are (1) a thrombo-arteritis or thrombo-phlebitis, and (2) a necrosis of bone and cartilage cells consequent to the disturbances of circulation produced by the plugging of the vessels. The physical characteristics of the pathological picture depend to the largest extent upon the second factor. The fact that a number of independent vessels furnish the blood supply leads to the circumstance that in epiphysitis the amount of bone in the epiphysis which necroses must necessarily correspond accurately with the extent of territory controlled by the plugged vessel as modified by the capabilities for collateral circulation from other arterial radicals which enter the substance of the epiphysis. In actual practice all grades of destruction can be seen. The maximum necrosis which results from a thrombo-phlebitic process in an epiphysis is seen most classically in the hip-joint where the characteristics of the blood supply of the head of the bone—a single nutrient artery passing in the ligamentum teres—lends itself peculiarly to total destruction of the head of the bone. Essentially there is an exact reproduction of all varieties seen in the diaphysis of a long bone—from minimum branch lesion to maximum nutrient artery trunk lesion—as previously described (ANNALS OF SURGERY, November, 1925).

Cases are seen rarely in which the radiographic evidences of the final extent of the lesion show simultaneous involvement of both epiphysis and diaphysis either in whole or in part, (1) either grouped apart from one another and separated by appreciable intervals of healthy tissue or (2) grouped together at one end of a bone. The physical basis of these atypical lesions in (1) exist in the occurrence of more than one independent fixation point within the confines of a single bone; and in (2) in the occurrence of (a) a single thrombo-embolic lesion in a larger vessel, the branches of

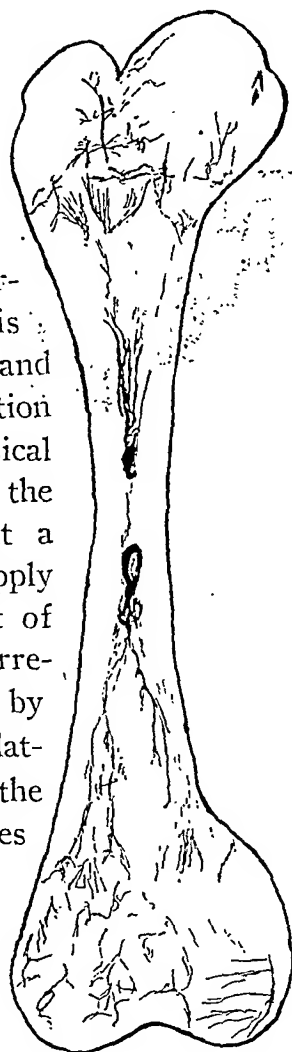


FIG. 2.—Circulation of the femur as shown by E. Lexer, Kuliga and Turck. Note the general similarity to the circulation in Fig. 1. Note that there is a single vessel which is perforating the head of the bone and that this is practically the entire blood supply for the head. Compare with Fig. 4. in which the results of a thrombo-embolic process in the vessel is shown and how closely the amount of bone destruction corresponds with the territory supplied by this vessel.

which supply both epiphysis and diaphysis where they lie in relation to one another, or (b) of independent fixation points in vessels supplying the epiphysis and diaphysis where they lie in relation to one another with primary overlapping of territory supplied with blood or with secondary fusion of the independent thrombo-phlebitic processes. Commonly, however, such combined lesions are the results of operation.

Clinically it is found that cases of acute epiphysitis, like cases of acute osteomyelitis in general, can be grouped into three varieties:

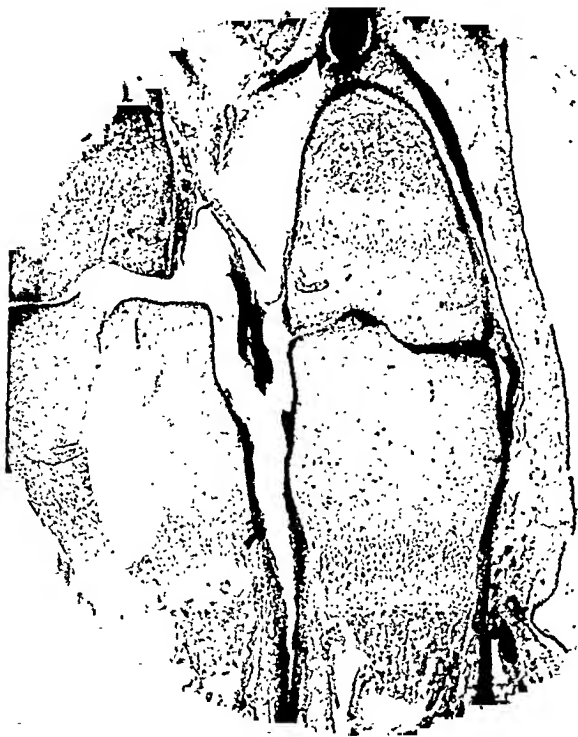


FIG. 3.—Longitudinal section through the bone of a foetal pig. Note the epiphysis, the conjugate cartilage and the diaphysis of which approximately half is shown. Note the centres of ossification in the epiphysis and in the diaphysis. The vascular areas surround these centres. On the epiphyseal side of the conjugate cartilage two vessels can be seen perforating the epiphysis from either side; these are derived from the periosteal circulation. Note the large avascular area on the diaphyseal side of the conjugate cartilage.

(1) In the first variety a focus is present in one of the epiphyses with well-marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteraemia is not present. The physical basis for this variety lies (a) in a primary and temporary bacteraemia; (b) in the development of a fixation point in the given epiphysis, and (c) the subsequent spontaneous disappearance of the bacteraemia.

(2) In the second variety a well-marked focus is present in one of the epiphyses with

abundant local signs and symptoms and, in addition, there are clinical indications of a bacteraemia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteraemia by constantly feeding into the blood stream a comparatively small number of viable organisms. Most commonly, either after or without efficient surgical treatment, the bacteraemia eventually disappear and a recovery is made. It must be remembered that any of these cases may at times pass into the third group.

(3) The clinical picture of the cases in this group is that of a profound general infection: there is a marked toxæmia. A local focus is either not demonstrable at all because of the paucity of local signs and symptoms, or

because the latter are hidden in the profound intoxication; or, if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis for the clinical picture lies in an extreme and severe general blood infection with highly virulent organisms in which the bacteria are rapidly multiplying in the blood stream and because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The presence of the infected thrombus-embolus formation forms a negligible factor and the few organisms that are derived from this source play only a primary and inciting part in the production of the bacteriæmia; the subsequent multiplication in the blood stream depends on other factors, the most important of which is the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation plays no rôle in the production of any part of the clinical picture. Usually the pathological anatomical picture is not in a very advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

In actual disease it seems certain that the cases differentiated in these groups form progressive stages each from the next preceding group. A case in group 1 may pass into group 2; and, conversely, a case in group 2, having been appropriately treated, may retrogress into group 1 as it proceeds to healing and recovery. These interchanges are constantly occurring in clinical surgery. A case in group 2 may pass into group 3 as is previously noted; usually under such conditions there is a continued progression until the eventual fatality. In actual practice cases in group 3 must necessarily first pass through the stages indicated by groups 1 and 2; the time interval may be so short, however, owing to the virulence of the infecting organism, or the relative non-resistance of the subject, as to make these stages unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in group 3 in this way. In many cases characteristics can be distinguished which belong to both group 2 and group 3; and insofar as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations. I have never seen a case in group 3 retrogress spontaneously into group 2; it seems almost impossible to believe that such retrogression can ever occur.

The most important local complication of acute epiphysitis is joint infection. It is a matter of great difficulty, clinically, to make correct judgments as to the coincidence or absence of an epiphysitis with an acute joint infection, as to the relative dominance of the one over the other part in the total clinical picture and as to the relation of either of them to an accompanying bacteriæmia. This is an especially great difficulty in the most severe cases of group 3, even though in these cases a fatality is always to be expected, and the differentiation would then be of no practical value. Clinically, a number of possibilities are present depending on the relation of the epiphysis to the interior of the joint capsule and to the reflection of the synovial membrane. Anatomically, the various epiphyses have variable relations to their corre-

sponding joint interiors depending on the physical structure of the individual joint; in some of the joints the epiphysis lies altogether outside of the joint; in others it lies outside of the joint only partially; in still others it lies altogether within the joint. The observable clinical possibilities are as follows:

A. An epiphysitis develops with or without abscess formation and during the entire course of the infection, there is no demonstrable evidence pointing to involvement of the joint. The physical basis for this naturally lies in the location of the fixation point in an epiphysis or in that part of an epiphysis which is entirely outside of the joint.

B. An epiphysitis develops with or without abscess formation and the clinical signs of joint involvement come only later. If this should appear before any operative incision, it indicates that the fixation point was originally situated in a part of an epiphysis which was outside the joint capsule and that joint involvement took place because of one of two factors: (1) either the death of tissue in the epiphysis consequent to the interference with the circulation resulted in sequestration which mechanically opened a pathway into the joint cavity; or (2) because of the spread of the infective process. The physical basis for the latter is the extension of the thrombo-phlebitic process ‡ along the vascular channels; and the most important, if not sole cause for the extension lies in the continued growth of living bacteria within the substance, and on the surface of the thrombo-phlebitic clot.

If the signs of joint involvement come after operation the possibilities are: (1) that the complication occurred from a mechanical opening into the joint and that the latter occurred during the operative manipulations either accidentally or perhaps, purposefully; or (2) the unavoidable cutting and traumatism of many vascular channels in the field of operation aided and abetted the spreading of the thrombo-phlebitic lesion.

I have the impression that, especially in acute epiphysitis, spreading of the thrombo-phlebitic lesion does not commonly occur in the absence of any outside interference. Joint complication is almost always due to a primary involvement of a part of an epiphysis which is within the interior of a joint. I have the further impression that most of the time spreading of the lesion appears *pari passu* with unwise operative manipulations. The more I see of these cases the more I am convinced that in the largest proportion of the cases—and this proportion seems to be constantly larger in my experience—the final extent of the undisturbed lesion corresponds to the extent of

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‡ The subject of vascular thrombosis is an extremely important one in explaining the mechanism and pathogenesis of bacterial infection in bone tissue. It has been adequately discussed on a previous occasion (*Arch. Surg.*, 1926, vol. xiii, p. 228 and *ANNALS OF SURGERY*, November, 1925) and the discussion will not be repeated here. Suffice to say that the spread of vascular clotting under the influence of (1) the original embolus-thrombus formation or (2) of persisting infection in the clotted area is the most important single factor (1') in explaining certain primary characteristics of acute osteomyelitis, (2') in enabling a proper classification of the various types of individual lesions, (3') in explaining certain hitherto obscure phenomena of the disease, and (4') in properly presenting a sufficient mechanism for the apparent or actual spread of the primary lesion.

territory deprived of its nutrition by the thrombo-phlebitic process; that, ordinarily, no increase of the extent of tissue involved occurs later; and that the total final extent of tissue involved is, for practical purposes, an accomplished fact at the very moment when a fixation point is firmly established at any given point of the vascular network of a bone either in the diaphysis or epiphysis.

C. An acute joint infection develops and at operation it is possible to demonstrate a focus of infection in an epiphysis in the interior of the joint. It is immaterial whether the given epiphysis lies wholly or partially within the joint; the focus of infection is in that part of it which lies within the joint.

With these fundamental facts in mind it becomes apparent that in the treatment of acute epiphysitis, exactly as in acute osteomyelitis in general, one has a two-fold object to accomplish: (1) the treatment of the general infection (bacteriæmia—general blood infection); and (2) the treatment of the local lesion.

#### TREATMENT OF THE GENERAL INFECTION (BACTERIÆMIA)

In any case a relative quantitative estimation of the magnitude of the infection can be established according to the number of colonies of bacteria which appear in the plate culture method in proportion to the amount of blood used to inoculate the culture medium—thus 1 or 5 colonies of bacteria per one cubic centimetre of blood as compared with 100, or an uncountable number of colonies of bacteria per one cubic centimetre of blood. This is a very rough method and is not strictly accurate, but for practical purposes the inaccuracy is inconsequential.

In practice the presence or absence of a bacteriæmia or general blood infection yields the following clinical groupings and the correct interpretation of the bacteriæmia in its relation to the clinical manifestations yield certain therapeutic indications.

A. Treatment of the general infection is many times not called for, as commonly the clinical manifestations of the general infection are mild and the natural protective agencies of the body are able to nullify the bacteriæmia and its effects. Many times, unless one understands the essential nature of the pathological process involved in the development of a focus of infection in an epiphysis, the question of the bacteriæmia does not enter into therapeutic consideration; this is so because, as pointed out on previous occasions, the initial bacteriæmia was a temporary phenomenon and sufficient time had elapsed between its appearance and the moment of observation to allow for its spontaneous disappearance. Under these circumstances there are no clinical or laboratory evidences of its existence. Good prognoses should be the rule under these circumstances.

B. At the opposite end of the picture are those fulminating, progressive and severe forms of bacteriæmia and general blood infection, the existence of which is associated clinically with a symptom complex in which the local focus of epiphysitis is of minor and secondary consideration and in which the



manifestation of the bacteraemia or general blood infection is the dominating factor in the entire clinical picture. Large numbers of viable organisms are demonstrable in the blood cultivations in such severe cases. The local focus may exhibit definite signs of its presence, or may be unrecognizable and undemonstrable owing either to the paucity of its clinical manifestations or to the profound intoxication produced by the general blood infection.

Any kind of local condition may be associated with such a general blood



FIG. 4.—The result of an acute epiphysitis in the upper epiphysis (head of the femur) of a young child. Note the amount of bone which has disappeared from the head as a result of the focus of infection and note how closely this corresponds to the territory as shown in Fig. 2 which is supplied by the artery which enters the head through the round ligament.

infection. It is to be assumed under such conditions that large numbers of viable organisms are being discharged into the blood stream from the thrombo-phlebitic area and that the bacteria are probably multiplying in the blood also. The prognosis must therefore be a very serious one. The usual course of affairs includes a steady progression of the general blood infection until a fatality occurs. Under these circumstances treatment directed to the local lesion is futile and fatalities are the rule and not the exception. One must understand that here one is dealing primarily with cases of general blood

infection and any treatment which is possible and permissible must be directed to the general infection; the local lesion plays a minor rôle. The promise that operation on the focus in the epiphysis "furnishes the unfortunate patient his only chance" is sometimes something which may not be refused in the presence of anxious parents, relatives or friends; but whenever such earnest desires are acceded to, it should be unequivocally emphasized that the "chances" are practically nil. In the fulminating cases the entire duration of the illness is most often a question of a few days.

There are other somewhat less severe forms of acute osteomyelitis in which the blood contains large numbers of viable organisms, but in which the clinical picture does not carry with it that comparatively sudden overwhelming of the body with a profound toxæmia. Following operation there is little



or no lessening in the magnitude of the bacteriæmia or, possibly, an increase in the latter. Under these circumstances the question of amputation should be discussed when the local conditions lend themselves thereto.

C. In between the mild cases of group 1 and the very severe cases of group 2 there exist large numbers of cases of acute osteomyelitis in which (1) there are well-marked evidences of one or more foci of acute osteomyelitis and (2) a demonstrable bacteriæmia.

Blood cultures obtained under these circumstances can be employed (a) in appropriate cases as an additional means of differential diagnosis; (b) as means by which the severity of the infection can be gauged; (c) as a help in estimating the prognosis; (d) as criteria upon which to base the primary or further operative treatment.

Occasionally the character of the organism demonstrated in the blood culture can be employed as a differential point in diagnosis. Cases are constantly being seen in which it is difficult to decide whether the localization has occurred in a bone or in a neighboring joint. True enough this sometimes indicates a simultaneous or successive involvement of both, but in other cases the localization is hidden in a general inflammatory reaction. Under these circumstances the demonstration of organisms of the staphylococcus group—*staphylococcus aureus* especially—indicates that the chances are greatly in favor of a primary involvement of bone tissue; the demonstration of organisms of the streptococcus group would speak in favor of a primary synovial involvement. The differentiation carries with it a possible therapeutic indication. Other things being equal, the demonstration of organisms of the staphylococcus group with its consequent interpretation of a bone lesion would ordinarily favor exploration of the bone in cases of doubt; while the demonstration of organisms of the streptococcus group would carry with it a more conservative attitude at least as far as exploration of the bone were concerned.

In cases of acute epiphysitis the relative magnitude of the bacteriæmia or general blood infection is capable of yielding information valuable for a correct gauging of the prognosis. This information can be classified as follows:

A. In cases of acute epiphysitis blood cultures showing approximately one to five colonies of organisms to the cubic centimetre of blood are usually, but not always, of a mild nature, frequently show little or no evidence of their existence, are associated with symptom complexes which do not differ materially from similar cases of acute epiphysitis in which the blood cultivations are sterile, and frequently disappear spontaneously or following operation. Good prognoses are the rule in these minor bacteriæmias.

B. On the other hand, blood cultures can be obtained in which the numbers of colonies are extremely large—100 or more colonies to the cubic centimetre of blood. Always this indicates a severe infection and an extremely grave prognosis. The clinical picture commonly shows an equal evidence of the severity of the infection. The interpretation of such blood cultures has been referred to already in considering the fulminant cases of acute osteo-

myelitis. There will be many cases in this group in which one will have no doubt as to the need for operation upon the local focus of epiphysitis and one will proceed confidently on these. There will be many other cases in this group in which one will be somewhat in doubt as to the correct interpretation of the relationship of the clinical picture to the bacteriæmia or general blood infection, especially in those cases bordering upon the fulminant cases referred to previously. Under such circumstances one must operate upon the local demonstrable focus of osteomyelitis and remove it radically when the local conditions lend themselves thereto.

C. In between these two extremes are large numbers of cases in which the blood cultivations show an intermediate number of colonies of bacteria. When a given blood culture is compared with subsequent ones taken on the same patient the lessening of the number of colonies, or their disappearance, undoubtedly bespeak an improvement *when other conditions are equal*. An increase in the number of colonies should always be cause for alarm and for a prompt reconsideration of the available clinical picture and revision of all the demonstrable foci whether they are in the bone or in complicating and associated foci in other tissues. Comparisons made along these lines are of extreme usefulness and importance in bedside and operating room work.

D. In the presence of a positive blood culture a prognosis of the ultimate outcome in cases of acute epiphysitis should not be attempted except after consideration of all the available clinical facts. While a positive blood culture is always a serious thing, especially from the point of view of the possibilities which may occur, it is usually found that the seriousness of the latter is paralleled by the characteristics of the clinical picture. The prognosis should always be guarded. Much depends upon the availableness of the local focus of infection for thorough surgical removal and upon the performance of the latter procedure before other uncontrollable complicating foci have appeared.

Negative (sterile) blood cultures, obtained either primarily or secondarily in cases of acute epiphysitis, should not always be associated in one's mind with the milder type of case or with improvement. Quite the contrary can be the case and negative blood cultures can be obtained in the presence of the most profound infections. The available clinical and laboratory data indicate that the demonstration of a sterile blood culture may be an accident and occur in the intervals between repeated temporary states of bacteriæmia and be associated with an autosterilization process which takes place in the blood or in certain important organs, especially the liver; the occurrence of complicating and secondary foci, other than the bone focus and subsequently to it, in the presence of negative blood cultures, is the most powerful proof of these temporary bacteriæmias.

In the presence of positive and negative blood cultures a progressive impoverishment of the general condition of the patient is frequently due to the magnitude and number of the various fixation points that have occurred or to their location in important viscera or localities of the body rather than to the presence of the blood infection and of its consequent toxæmia. Posi-

tive blood cultures are sometimes only obtainable at a late stage of the illness. Death results either from a general progression of the entire infection or from the results of any one particular manifestation—as, for instance, from the results of a localization in the lungs and pleura.

The actual treatment of the bacteriæmia or general blood infection is the surgical removal of the focus of infection containing the thrombo-arteritis or thrombo-phlebitis from which the bacteriæmia or general blood infection is derived. In any given case the presence of the bacteriæmia may be referable (1) to the original primary lesion, (2) to its secondary focus in the bone, (3) to the presence of a focus subsidiary to the secondary focus (bone or other) which by itself is capable of creating a bacteriæmia, (4) to the presence of a valvular lesion (endocarditis) and (5) to the presence of some other complication capable itself of giving rise to a bacteriæmia or general blood infection.

Except in cases of acute epiphysitis which follow specific infections as pneumococcus pneumonia, etc., or which follow certain definite conditions as an acute mastoiditis with thrombosis of the latent sinus, and which make their appearance during the course of the primary illness, the primary lesion to which the focus of infection in the epiphysis is secondary, is not ordinarily recognizable or demonstrable by the ordinary clinical or laboratory means. In the average case seen the question of the primary lesion does not enter.

In practice one should assume under any other circumstances than those just mentioned that the bacteriæmia is most likely derived from one or other of the foci demonstrable in the epiphyses.



FIG. 5.—An X-ray photograph of the final result of an acute epiphysitis of the head of the femur in a young child taken two years after the onset of the illness. The focus in the head of the femur was subsidiary to a thrombosis of the lateral sinus which complicated an otitic infection. The hip was treated conservatively and operation of any kind was not found necessary. There was complete recovery. The functional end result compares very favorably with that of the case, the X-ray of which is shown in Fig. 4.

## THE TREATMENT OF THE LOCAL LESION

The treatment of the local lesion of an acute epiphysitis similarly to that of acute osteomyelitis should be based (1) upon a consideration of the mechanism by which the foci are produced; (2) upon the character of the lesion which is produced, as determined by the available knowledge and by röntgenographic evidence; (3) in accordance with the magnitude of the infection in association with the absence or presence of a bacteriæmia, and (4) in accordance with the presence or absence of associated or complicating lesions, especially joint complications. Multiple epiphyseal foci should be treated individually along similar lines and in accordance with the viewpoints and rules herein expressed.

A. Other things being equal, the absence of a demonstrable bacteriæmia or general blood infection indicates that a conservative attitude can be assumed in deciding the correct method of surgical treatment of the local focus of infection in the epiphysis. The immediate and late importance of this conservative attitude is so great as to make it the attitude of election whenever it can be possibly employed. The immediate and late benefits of conservative forms of treatment can be summarized as follows:

(1) The avoidance of any operative intervention in many cases of acute epiphysitis. From time to time cases of this kind are met in practice. Quite commonly these cases complicate the sinus thrombosis which follows an acute mastoiditis; and quite frequently the lesions are in one or more of the epiphyses in the neighborhood of the hip. Joint complication is almost always present and the clinical manifestations are largely due to the latter. Even in the presence of high fever—frequently protracted for considerable periods of time—and of other signs of toxæmia, conservative forms of treatment are always indicated when the blood cultures are sterile. The indications can be adequately met by traction and immobilization and the subsequent results have demonstrated that the natural forces of the body have been ample to control the focus of infection and to bring about an efficient healing. The late results as regards function have been very good; curtailment of the normal ranges of motion have been inconsequential and of minor degrees or have been reduced to a minimum.

(2) A much less severe—frequently, indeed, a minor primary operation in the cases with sterile blood cultures in which the operation should prove necessary. Under the circumstances the necessity for operation arises only because of an excessive accumulation of purulent matter and the latter collects (a) within the interior of the neighboring joint, (b) exterior to it under the periosteum, or in the fascial planes of the limb, or (c) in more than one of these locations either simultaneously or as developments the one from the other.

The only indication to meet under these circumstances is the introduction of adequate drainage. The actual methods of doing so follow general surgical principles and comprise (a) the simple opening of abscesses in the soft parts;

(b) the opening of subperiosteal abscesses; and (c) the drainage of joints. In any case free drainage should be provided.

(3) The much less chance of the spreading of the thrombo-phlebitic or thrombo-arteritic lesion with all the consequences hereinbefore outlined. This advantage, valuable beyond anything else, is guarded by the avoidance of any operative intervention and is least disturbed by the method of operative intervention indicated—the introduction of simple drainage.

(4) The conservation of important bone tissue. This is of maximum importance in any component which enters into the structure of a joint.

(5) The avoidance of secondary sequestrotomy. Owing to the structure of epiphyses the bony foci are necessarily limited in size; the resulting sequestra are small; and within the confines of a joint absorption of the latter is a phenomenon of extraordinary rapidity. Under the circumstances secondary sequestrotomy seems to be necessary very rarely.

The results of this plan of treatment for cases of acute epiphysitis have been very good. There is much less deformity. There is a greater usefulness because of a greater conservation of the normal structure and functions of the epiphyses and their related joints.

B. Other things being equal, the presence of a demonstrable bacteriæmia or general blood infection indicates a dangerous and possibly progressive lesion and bespeaks an urgency of effort which seeks to remove the guilty local focus as early and as completely as possible before irreparable damage is done by the spreading of the infection to the endocardium or other important organ or locality. All of the information classified in the previous part of this and in other papers as regards the clinical and therapeutic significance of a bacteriæmia or general blood infection accompanying any of the forms of an acute osteomyelitis come into play at this time and judgments should be based and indications met accordingly.

The important indication is to remove the local focus in the epiphysis as completely as possible. Conservatism should be replaced by radical removal of bone tissue frequently into healthy areas. The difficulty during these early stages is one of two:

1. The impossibility of being able to recognize the limits of the lesion in the epiphysis. The impossibility of determining clinically, or of demarcating accurately even upon operative exposure, the exact extent of disease in any given bone is an important characteristic of the early stages of the development of a focus of infection in osseous tissue. The physical basis for this exists in the manner and extent of intraosseous vascular clotting, of the consequent disturbance of intraosseous circulation and of the capabilities for collateral blood supply. Owing to the physical structure of the bone, changes are not visible to the unaided eye or on an X-ray photograph at these comparatively early stages of the development of the focus, *i.e.*, at the time these cases are usually operated upon. Röntgenological evidence of all of these structural changes only become recognizable (a) after the bone cells have died and after the bone matrix has begun to sequestrate, in which case

the discriminating shadows forming lines of demarcation and areas of absorption, rarefaction find their physical basis in the disappearance of lime salts; and (2) after new bone—involucrum—has been deposited around the sequestered portions, in which case the discriminatory shadows are due to the deposition of new lime-bearing tissue; both of these physical conditions are the products of long-continued activity of processes of disease and of processes of healing and only become recognizable at a late stage. Röntgenological evidences of the “first appearances and of the subsequent development” of a focus of osteomyelitis in an epiphysis, are very liable to mislead one unless they are properly interpreted.

2. Epiphyses are commonly important component parts of joint structures. Under the circumstances the times and localities in which radical removal of the thrombo-phlebitic focus in the epiphysis is not technically possible are frequent. In addition the immediate proximity to important conjugal cartilages, and the wish to conserve as much as possible of the skeletal structure in order to preserve as much as possible of the normal growth and functions, makes undesirable any radical removal of the focus of infection in an epiphysis. In actual practice these two criteria frequently disturb and prevent ideal methods of treatment of the local epiphyseal lesion in the presence of a bacteriæmia. As much as possible should, however, be done in the way of removing the entire focus; ample drainage should be secured in addition as the next best thing; and a good deal must be entrusted to nature's efforts in spontaneously dissipating the bacteriæmia. In actual practice this incomplete method of treatment works out fairly well in the milder type of bacteriæmia; spontaneous regression and disappearance of the bacteriæmia frequently takes place and the disease continues as if no bacteriæmia had existed. In the severe type of general blood infection, one is frequently compelled to disregard anatomical structure and subsequent disturbance of function and to proceed ruthlessly to remove the entire focus of infection; the question of amputation frequently comes up; success does not always follow. In the most severe type of infection—as indicated in a previous part of this discussion—it should be recognized that operation is futile.

The clinical possibilities which follow operation and the therapeutic indications which are available are the following:

A. In many of the cases a single focus of epiphysitis only is demonstrable and a comparatively small number of bacteria is demonstrable in the blood circulation (plate culture method). If following an adequate operation in which the demonstrable focus is removed, the blood becomes sterile, the pre-operative assumption that the bacteriæmia had resulted from that particular focus becomes confirmed. In some of the cases, however, the bacteriæmia persists after operation. When the surgeon is certain that the bone lesion has been so thoroughly removed as to be impossible of causing the bacteriæmia and when the appearances of the bone wound corroborates this impression, the bacteriæmia should be used as an indication that some other focus exists which must be found and removed in order to render the blood sterile. Many

times this proves to be the case; but when it does not, the original focus should be examined again and revised operatively if possible. If the bacteriæmia still persist and the number of demonstrable bacteria is still comparatively small, the explanation of the bacteriæmia cannot be decisive, because in epiphyseal foci radical removal of the entire focus must necessarily be frequently incomplete for the reasons just indicated. In the meanwhile other foci should be looked for constantly during the continuation of the bacteriæmia. Fortunately in most of these cases the natural forces of the body are ample after a sufficient lapse of time to render the blood sterile.

B. When several foci of osteomyelitis coexist in the presence of a bacteriæmia, the explanation of the latter becomes a matter of exclusion. Similar rules to those outlined in the last paragraph apply.

C. In many of the cases of acute epiphysitis—especially in those which follow the mastoid-sinus-thrombosis cases—the primary lesion is demonstrable as well as one or more subsidiary bone lesions. In the majority of the cases the bacteriæmia disappears after efficient surgical treatment directed toward all of the demonstrable lesions primary or other. In a few cases, however, the bacteriæmia persists, although in some of the latter cases, because of the character of the primary lesion or of the infecting organism, or because of other reasons, it is possible to say with a fair degree of certainty that the primary lesion is keeping up the bacteriæmia. In all of the others the proper explanation becomes a matter of exclusion also in accordance with the rules laid down.

D. In some of the cases of acute epiphysitis with bacteriæmia, a subsidiary focus has developed in a tissue or organ other than bone, or a complication develops which is unrelated to the epiphysitis. Except in those cases of complication in which the latter is known from previous experience to cause a bacteriæmia or general blood infection, the proper explanation again becomes a matter of exclusion as previously indicated.

E. In any case in which the question of the bacteriæmia cannot be adequately explained and in which it continues to exist an endocarditis should be looked for. The presence of the latter is the most serious complication possible and a very grave prognosis should be made; operation on any local focus is futile in the presence of a bacterial endocarditis and a fatal outcome should be expected.

Patients in the first four groups of this classification may at any time progress into the group of most severe and fulminant cases. They assume characteristics of the cases in this group and the clinical manifestations increase in gravity proportionately and absolutely. Similarly therapeutic indications exist as were previously pointed out. It is very rare for the opposite course to be followed. This change has intimate relation with a spread of the thrombo-phlebitis as previously referred to and may occur spontaneously either before or after operation or as a consequence of the latter. The possibility of this change occurring spontaneously before operation in cases of any form of acute osteomyelitis, even when previously a sterile blood culture

had been obtained, is the chief reason why authorities consider cases of acute epiphyseal infections emergency cases which brook of little or no delay before operation.

In performing the secondary sequestrotomy only as much healthy bone or—involucrum—should be removed as to enable one adequately to remove the sequestrum. The main care is not to cause undue mutilation and to prevent the spread of the thrombo-phlebitis inasmuch as this is the chief cause for the subsequent exacerbations or recrudescences in the same focus or in the production of other foci. The resulting wounds should not be sutured and should be allowed to heal from the bottom either with or without the aid of sterilization by the Carrel-Dakin method. The presence of exposed joint surfaces and the desire not to increase the damage or injury already existing within the given joint, or the risk and danger of opening into the joint during the sequestrotomy, are frequent handicaps to the surgical technic. In some cases the risk must be disregarded in the endeavor to cause the surgical wound to heal; this will necessarily be so when sinuses already exist which lead into the interior of the joint. In other cases, with intact and uninfected joints, and even in others where an exudate of some kind is present in the joint, a conservative policy may be permitted and may even be advisable; I believe that the latter goes a long way toward an increased conservation of joint function.

The experiences upon which the deductions of this communication are based are derived from the study of clinical cases admitted to the service of Doctor Moschcowitz and in my own private practice. I am indebted to Doctor Moschcowitz for permission to carry on these studies upon the patients admitted to his service.

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# THE RECONSTRUCTION OPERATION FOR DEFORMITY SECONDARY TO DISEASE AT THE HIP-JOINT

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IN THE ANNALS OF SURGERY for December, 1924, and June, 1925, I described a modification of the reconstruction operation, originally, designed for ununited fracture of the neck of the femur,<sup>1</sup> as adapted to the treatment of advanced arthritis deformans at the hip-joint.

It was noted as characteristic of this disease, that irrespective of its exciting cause, the progress of the destructive process in the joint was determined by the friction of the irregular surfaces of the femur and acetabulum on one another, and by the weight and strain to which the weakened part might be subjected.

The object of the operation was to reduce this destructive attrition by lessening the area of contact and transferring it from the outer to inner part of the acetabulum.

The joint having been exposed and the deformed femoral head extruded, it was com-



FIG. 1.—Shows the destructive changes in the joint, secondary to incongruity in childhood; particularly the impingement of the trochanter on the ilium and the obliquity of the acetabulum. The compensatory upward tilting of the pelvis is also shown.

pletely reshaped, the greater part being removed together with all the degenerated cartilage, leaving a smooth, rounded extremity of about the diameter of the neck. The trochanter was cut through at its base and transplanted to the outer surface of the shaft at a sufficient tension on the attached muscles to hold the limb in a moderate degree of abduction. This permitted the remodeled extremity to be thrust deeply into the acetabulum where the cartilage as contrasted with that about its outer margin was in fairly normal condition.

By this form of arthroplasty one might relieve the symptoms, check the progress of the disease and yet preserve a useful range of motion.

This type of operation has been employed in a number of other conditions, three of which are presented as of interest from several points of view.

<sup>1</sup> *Surgery, Gyn. and Obstetrics*, June, 1921.

The first patient, a man now thirty-two years of age, was seen when a child in 1901. He then according to the record presented the characteristic physical signs of coxa vara, and as it was stated that he had always limped, it was thought that the deformity might be of congenital origin.

The depression of the neck was corrected by a cuneiform osteotomy at the base of the trochanter. This operation, according to the mother relieved

the symptoms and he was not seen again until November, 1926. He stated that he had had but little disability until during the past year when the limp had become more noticeable and the local discomfort more persistent.

He was in good physical condition. There was a marked limp on the left side. The trochanter was elevated. The limb was adducted and the compensatory tilting of the pelvis caused an apparent shortening of two and a half inches. The range of flexion and extension was also somewhat restricted and forced movement caused pain.

The accompanying X-ray picture shows an extreme degree of coxa vara with distortion of the head. It may be

FIG. 2.—After operation—showing, as contrasted with figure one, the changed relation of the transplanted trochanter to the ilium and the symmetry of the new bearing surface.

noted that the trochanter is in close apposition to the pelvis, completely checking abduction, which is still further restricted by a projection of bone from the base of the neck. The appearance of the joint when exposed at operation was similar to that of arthritis deformans. The upper surface of the head and neck resembled somewhat the back of a spoon. The roughened, irregular cartilage formed excrescences about its lateral borders and there were several loose cartilaginous bodies in the joint. The distorted head was reshaped with a chisel and file into a smooth, rounded extremity and the

## OPERATION FOR DEFORMITY AT THE HIP-JOINT

trochanter transplanted in the usual manner as shown in the second X-ray picture taken through the plaster soon after operation.<sup>2</sup>

It may be noted that the trochanter, formerly in contact with the pelvis, now stands at a sufficient distance from the acetabular rim to permit a full range of abduction, and as the new head is solid and symmetrical the progress of the destructive process should be checked.

The second case is of a similar type, although of a different cause.

The patient, a woman thirty-five years of age, was first seen in January, 1927, the



FIG. 3.—Case II. This shows what resembles an epiphyseal fracture. The impact of the neck with the view of the acetabulum prevents the reduction of the adduction deformity.

FIG. 4.—Case II. After the reconstruction operation. The distorted head has been removed and the extremity of the remodeled neck placed in the acetabulum.

physical signs and symptoms corresponding closely with those of the case already described.

It was stated that when she was twelve years of age she had been confined to bed for several months by so-called rheumatism of the hip. After recovery, except for the limp, she had suffered comparatively little inconvenience. Within the past three years, however, there had been increasing discomfort and disability, chiefly awkwardness and insecurity.

It may be noted in the X-ray picture that the appearances resemble those of an old fracture of the epiphyseal type, the projecting angle of the neck impinging on the acetabular rim checking abduction completely. This may have been a direct effect of injury but more probably the displacement was secondary to disease.

On February 7 of the present year the reconstruction operation was performed. The head of the bone was found to be much distorted, the cartilage presenting the typical appearances of arthritis deformans, thus accounting for the pain on movement of the joint.

<sup>2</sup> The operation is indicated in advanced cases of Legg-Perthes disease for the removal of the degenerated and distorted epiphysis.

These cases are of interest in their bearing on the etiology of arthritis deformans, illustrating how a so-called incongruity of the joint in childhood may induce changes in later years closely resembling those of primary disease.<sup>3</sup>

The third case was a direct result of disease. The patient, a woman thirty-five years of age, the daughter of a physician, had been treated for tuberculosis of the hip-joint for many years during later childhood and adolescence. She recovered eventually and according to her statement there had been but little disability until during the last

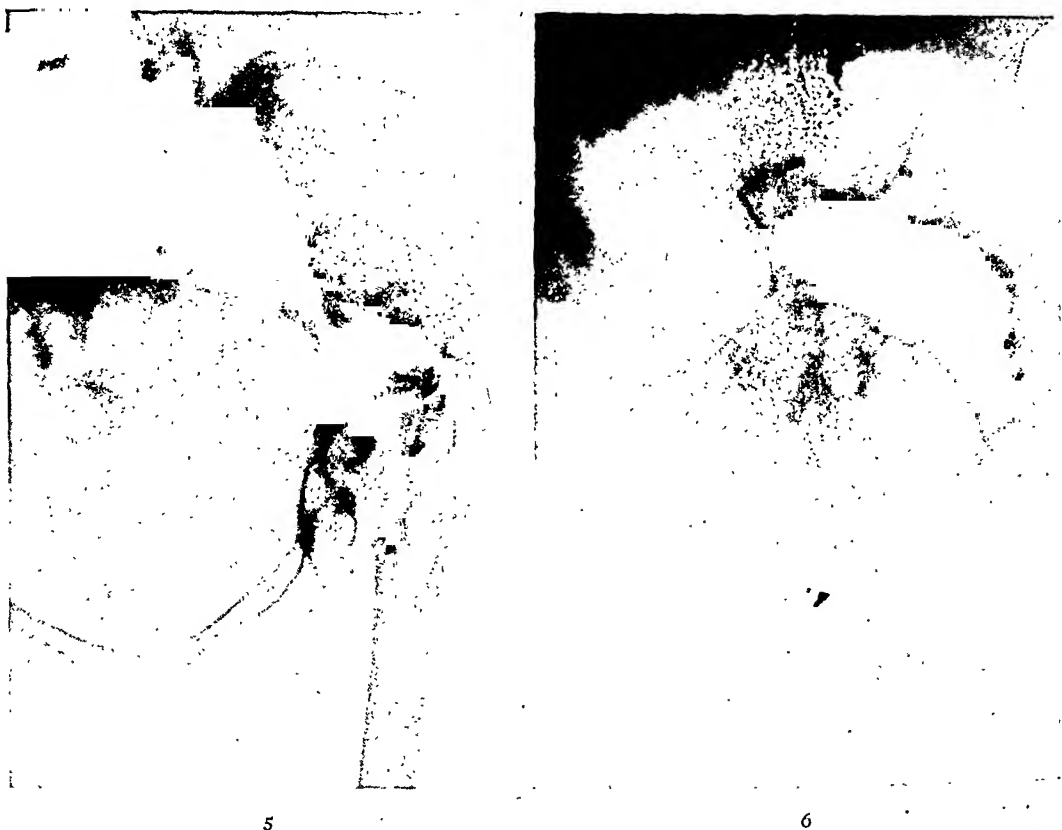


FIG. 5.—Case III. This shows the destructive effect of the original disease, the upward tilting of the pelvis and the contact of the trochanter and acetabular rim.

FIG. 6.—Case III. Taken through the plaster spica after operation. Shows the abduction of the limb made possible by removal of the trochanter.

year when the limp and deformity had increased, and it was on this account rather than because of pain that treatment was desired.

The limb on the affected side was flexed and adducted as in the preceding cases, though to a more extreme degree, the apparent shortening due to compensatory tilting of the pelvis being four inches.

The X-ray picture shows the destructive effect of the primary disease. The acetabulum is enlarged and the bearing surface of the femur has been reduced to a finger-like projection, which with the increasing adduction of the limb has become more unstable as a support. The relation of the trochanter to the acetabular rim is such as to check abduction absolutely demonstrating clearly that its removal is essential to the reduction of the deformity.

The operation was performed on February 28 and the picture taken through the plaster shows that the adduction deformity has been corrected and that the former

<sup>3</sup> This point is best illustrated by the Legg-Perthes disease and congenital dislocations and subluxations at the hip.

## OPERATION FOR DEFORMITY AT THE HIP-JOINT

bearing surface, supplemented by the area obtained by removal of the trochanter now contained within the acetabulum, forms a secure support.

These cases are presented, not to illustrate the results of treatment, but to demonstrate the mechanics of the reconstruction operation. The distinctive features that justify the name reconstruction being transplantation of the trochanter; to remove a direct mechanical obstruction to the reduction of deformity, to provide a new bearing surface and a wider range of lateral motion, and to restore the leverage of the abductor muscles.

The purpose of the reconstruction operation in design and in supplemental treatment is to provide a sufficient range of abduction to restore symmetry and to assure stability.

The plaster spica applied at the operation in extension and about 20° of abduction is usually retained for about a month, when it is assumed that the transplanted trochanter will have become united with the shaft. If the patient remains in the hospital the limb is suspended from a frame for passive movement and muscular reëducation. In other cases a short spica is applied and the patient is permitted to walk about with or without crutches as may be indicated by the degree of discomfort.

In cases of the types under consideration, in which the deformity is of long standing, there is always a tendency toward a relapse to the former attitude. Therefore in the after-treatment, daily, methodical, manual "stretching" of the limb to the attitude of extension and abduction in which it was fixed at the time of the operation must be continued until the patient is able to carry out the movements voluntarily.

This point is emphasized because its importance is not generally appreciated. One often sees patients presented as successful results of bone-pegging for ununited fracture at the hip or as illustrating restoration of motion after arthroplasty for ankylosis, in which the range of abduction is absolutely restricted. I conclude, therefore, that transplantation of the trochanter should supplement any form of operative procedure in cases of this class.

As has been stated the reconstruction operation was originally designed for the treatment of ununited fracture at the hip, but in recent years it has opened a larger field in the treatment of arthritis deformans. In these cases of confirmed so-called *malum coxæ senilis* the disabling symptoms are caused by friction of the irregular and roughened surfaces of the joint upon one another. It is evident, therefore, that neither internal medication nor local applications can have any material influence on the progress of the disease except in so far as they are combined with rest. Furthermore, as splinting of this articulation for indefinite periods is impracticable operative intervention offers the only effective remedy. Formerly there was no alternative to arthrodesis. This operation was by no means always successful and as patients strenuously object to a "stiff" joint it has been restricted to advanced cases. The reconstruction operation has therefore the great advantage that

since it is designed to improve function it may be utilized to forestall the long period of painful and progressive disability.

The operation as adapted to arthritis deformans was first described in 1924 (*ANNALS OF SURGERY*, December, 1924). At that time seven cases were reported, since then thirty-six others have been operated on by this method at the Hospital for Ruptured and Crippled.

It is, of course, evident that in cases of this type it is impossible to restore the normal condition. The results, however, from a comparative standpoint, have been very satisfactory, and as symmetry has been restored and the destructive attrition reduced, one may fairly count on permanent improvement.

# TRANSACTIONS

## OF THE

### PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held March 7, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

#### APPENDICITIS WITH NON-DESCENT OF THE CÆCUM

DR. SEARLE LANYON, by invitation, presented the history of a patient who had been under the care of Dr. Hubley Owen, at the Philadelphia General Hospital. A man was admitted to the Special Surgical Ward of the Philadelphia General Hospital on November 1, 1926, with the chief complaint of abdominal pain localized in the right upper quadrant associated with nausea and occasional attacks of vomiting. Two years prior to his admission to the hospital he had an attack of severe colic in the right upper quadrant of his abdomen. This continued for a day or two and gradually disappeared. Six months after this attack he had a second attack of the same character only more pronounced. Most of his pain was confined to the right upper quadrant with occasional pain in the lower right quadrant. In the beginning the pain was very sharp. Later he described it as being "a dull, aching pain." He did not vomit and felt nauseated. This second attack continued for about two days. One month later he had another attack which was practically the same in its manifestations as the previous two attacks. Following this the attacks became more and more frequent. In August, 1926, he states he had an attack of jaundice. A week prior to his admission he had another severe attack of pain in the right upper quadrant of his abdomen associated with jaundice and persistent vomiting. The pain had no relation to the time and type of nourishment. He frequently took sodium bicarbonate without relief.

The man was white, thirty years of age, well developed, well nourished. His abdomen was soft and flaccid. Liver and spleen were not palpable. No palpable masses. There was subacute tenderness over McBurney's point, also the upper right quadrant in the region of the gall-bladder.

Urine showed no abnormality. Blood count showed 7400 leucocytes. Red count and hæmoglobin normal. Wassermann, negative. Blood sugar was 80. Blood urea, 13. Blood uric acid, 4. Vandenberg was negative. Icteric index was 6.

X-ray examination showed the greater curvature of the stomach situated 10 cm. below the iliac crest. It was of the fish-hook type. Peristalsis was normal. Conus was normal and no filling defects. The head of the barium column was at the hepatic flexure in six hours. In twenty-four hours practically all of the barium had been evacuated but some was still remaining at the cæcum. The ascending colon was not demonstrable in the lower right quadrant of the abdomen. It appeared as though the ascending colon was in the right upper quadrant of the abdomen. The appendix was not visualized. No evidence of organic lesion of the stomach or duodenum.

November 8, a McBurney incision was made. No large intestine was found in the right iliac fossa. The incision was enlarged upward along the outer border of the rectus muscle by splitting the anterior sheath of the rectus muscle and retracting the right rectus muscle toward the midline. The

cæcum was located below the liver. The appendix was kinked on itself and was bound to the liver and gall-bladder by a number of adhesions. The appendix was removed. The gall-bladder showed no pathology. Following the operation the man returned to the ward in good condition. Temperature, pulse and respiration remained normal. Stitches were removed on the seventh day and the patient was discharged from the hospital November 19, 1926.

Cases of non-descent and non-rotation of the cæcum present a number of interesting features from the clinical as well as from the embryological standpoint. The presence of intra-abdominal pain and tenderness in certain locations is taught as a guide to diagnosis. Unusual cases such as the one herewith reported show a variety of symptoms which are instructive nevertheless misleading.

Since operating on this case the reporters have made X-ray studies after a barium meal in a number of cases of subacute and chronic appendicitis and have found that the cæcum is frequently high in the right upper quadrant due to its failure of descent. This has been useful as a guide for the incision in such cases.

#### URETERO-COLONIC FISTULA

DR. LLOYD B. GREENE, by invitation, reported the case of a woman, age thirty-eight, who was admitted to the Pennsylvania Hospital, April 19, 1926, with the chief complaint of pain in the back. Ten years ago the patient had an attack of acute pain in the right lumbar region. This lasted one hour, during which time she passed cocoa-colored urine. The pain subsided and the urine became clear. There were a few strands of material that she thought were blood. One month later, there was a second attack similar in every detail and the third attack one month later. The only treatment consisted in diuretic pills. Three months after this onset she had a fourth attack of pain, after which she passed a brown stone about  $\frac{1}{8}$  inch by  $1\frac{1}{4}$  inches. The stone resembled a date stone. Following this she was free from symptoms for a period of six years when right lumbar pain recommenced. The pain was now dull in character, lasted about twenty-four hours, and radiated to the right anterior portion of the abdomen. Following the painful attacks she noted a heavy feeling in the bladder which lasted two days. For the three months preceding admission to the hospital the painful attacks and the heavy feeling in the bladder were followed by the passage of cloudy urine. The urine clears up promptly and she is again quite comfortable until the pain in the right lumbar region recurs. The pains have never been referred to the groin and they have always been on the right side. The attacks have been irregular, sometimes weekly and sometimes once in four or five weeks. The last attack was four days before admission. The patient gave a history of having had three abdominal operations; the first for pelvic inflammatory disease; the second for some unknown condition; the third for a tumor of the right upper quadrant. She has not menstruated since the first operation, five years ago. Following her marriage she had fifteen miscarriages in a period of four years and then three normal children. Routine examination revealed nothing unusual. The urine was loaded with pus. The phenolsulphonaphthalein test showed elimination of 25 per cent. of the dye in the first hour and 15 per cent. in the second. Cystoscopic examination revealed the following: Bladder contained slightly cloudy urine. Capacity normal. Bladder very tolerant. There was some slight cystitis. The right ureteral orifice appeared ragged, swollen and œdematous. There was no ulceration in the ureteral area, but considerable inflammation. The left ureteral region was normal. No. 6 F. catheters passed to the normal level



of each kidney pelvis without any difficulty. Normal flow of urine from the left catheter—urine slightly blood-tinged but otherwise grossly normal. Nothing was obtained from the right catheter until after the injection of sterile water, when a large quantity of pus was aspirated. The pus was too thick to come away spontaneously, and had an exceedingly foul odor. The differential phthalein test showed appearance time from the right kidney—none in twenty-five minutes, and from the left—four minutes—full concentration. Percentage output: Right—none in one-half hour period; left—17.5 per cent. in fifteen minutes. Pyelogram—right kidney—syringe method. After extracting as much pus as possible, 100 c.c. of 12.5 per cent. solution of sodium iodide was introduced without pain. Stereoscopic plates taken. The specimens of urine obtained by ureteral catheterization showed: Right—cloudy, acid—loaded with pus, few red blood-cells, few organisms, culture shows streptococcus indifferens. Left—clear, acid—few red blood-cells, no pus cells, no organisms, culture sterile. X-ray of the genito-urinary tract revealed a shadow which is properly in line for the position of the right ureter and on about a level with the lower border of the fourth lumbar vertebræ. This is of considerable size, some 7 or 8 mm. in diameter, and fully 2 cm. in length. There is good reason to suppose that this shadow may be in the ureter.

In a right pyelogram the same shadow is seen closely contiguous to the catheter. There is a hydronephrosis with a defect on the lower, renal aspect of the pelvis, which indicates the pressure of some body pressing upward and outward into the pelvis, or against it. The most striking feature of the examination, however, is the entrance of the iodid solution directly into the cæcum and ascending colon. There can be no question as to the presence of a reno-colonic fistula.

After a barium injection no abnormality of the fillings of the colon could be seen under the fluoroscope; but, after the fluoroscopic examination, the patient was removed to the table and stereoscopic films made which show a very distinct dilation about the cæcum, and it would appear that the fistula must connect with the posterior aspect of either the cæcum or the very lower portion of the ascending colon. The colon enema was accomplished without any unusual feature of any kind.

The patient was operated upon by Dr. Leon Herman and Dr. Charles F. Mitchell on April 29. The incision extended from the lumbar triangle to a point one inch below umbilicus and one inch to the outer side of the semilunar line. Relatively small kidney palpated rather low in position and surrounded by thickened and very dense organized scar tissue. The outer border of the kidney and its upper pole were rather easily mobilized, but the lower pole and the pelvic area were densely adherent. The ureter was felt as a greatly thickened, rigid cord about one and one-half inches in diameter. The tissue around the ureter was broken through, but it was found impossible to mobilize the tube. The lower pole of the kidney was freed but could not be brought up into the wound. This prevented visualization of the fistulous tract which was apparently situated at the upper end of the ureter at or near the uretero junction. It was at first thought necessary to amputate the kidney from the pelvis, but a line of cleavage was found between the peripelvic scar tissue and the thinned-out pelvic wall which permitted the placing of clamps so that most of the pelvis could be removed with the parenchyma. On the surface of the tissue that had been separated from the anterior surface of the pelvis, a small necrotic area suggestive of a sinus was seen, but this would not admit a probe and the operators finally concluded that it was not the fistulous opening. The area was surrounded by a purse-string suture

and oversewed. The pedicle was transfixed under each clamp and tied. On examination of the kidney, which represented a pyonephrosis, not any larger than, if as large, as a normal kidney, the parenchyma was found to be intact. On the anterior surface of the pelvic wall was a small round hole which was taken to be of traumatic origin. The final conclusion was that the kidney with the major portion of the true pelvis had been removed and that the fistulous communication was situated below the level of amputation, that is in the very lowermost portion of the true pelvis or in the ureter. The major part of the inflammatory reaction as evidenced by the great mass of scar tissue especially around the proximal portion of the ureter, tends to support this view.

**Pathological report:** The kidney is small with irregular pale granular surface. The specimen weighs 60 grams and measures 9 x 4 x 3.5 centimetres. The pelvis is dilated, walls thickened and mucosa hemorrhagic and covered with slight purulent exudate. Considerable fat is present in the renal parenchyma and a few small abscesses are present throughout. Practically no normal architectural arrangement is noted and homogeneous pallor extends throughout.

**Microscopical Examination.**—The glomeruli are hyalinized. The tubules are few in number, epithelium is narrow. Diffuse fibrosis extends throughout with obliteration of renal substance. The vessel walls are thickened. Foci of round cells, the centres of which are necrotic and many clumps of polymorphonuclear cells are scattered throughout. In a few places there is proliferation of blood-vessels in loose infiltrated granulation tissue. A few pleomorphic bacilli are scattered in the midst of infiltrated areas.

**Diagnosis.**—Extensive pyelonephritis.

The post-operative convalescence was somewhat prolonged as would be expected. Five days after the operation, there was noted some faecal discharge from the wound. This was of very short duration. The patient was discharged to the dispensary on June 2, 1926. She was readmitted to the house on September 9, 1926, because of the unusually large quantity of purulent drainage from the sinus. She was feeling quite well and had no other symptoms.

The sinus was injected with an opaque solution and stereoscopic plates were taken. The capacity was 15 c.c. Doctor Bowen reported as follows: "The fistula followed to the depth of the normal kidney pelvis, where there is an ampulla one and one-quarter by two cm., densely filled. There is a small diverticulum from this, extending inward and backward for about two cm. Somewhat further down, in the line of the ureter and at the level of the lower half of the fourth lumbar vertebra, there is a semi-dense oval shadow, some three cm. in length, which would appear not to be due to injected fluid. Under ordinary circumstances we would first think of a large ureteral calculus containing a rather small amount of calcium.

The patient was finally discharged October 13, 1926. The sinus was less than an inch in depth and the discharge had practically ceased.

DR. J. L. HERMAN called attention to the relationship of the ureteral catheter to the shadow cast by the injected medium. In the flat plate it would seem that the tip of the catheter had entered the colon, but this is only apparent. As seen in stereoscopic films, the tip of the catheter is situated at least one-half inch from the diverticulum of the cæcum, which latter was placed over the renal pelvis, this being in all probability the site of the fistula.

## PULMONARY ACTINOMYCOSIS

Stereoscopic films alone are of major importance in the diagnosis of these conditions. The speaker rarely makes flat plates in pyelographic work.

The operation was difficult chiefly because of very dense adhesions at the uretero-pelvic region, and very great thickness of the upper ureter, which facts indicate the site of the fistula as being in the lower portion of the pelvis or upper ureter. Following the operation, a small temporary fecal fistula developed, probably due to trauma rather than to exposure of the fistulous tract at the time of operation. The kidney and major portion of the renal pelvis were removed, but it is questionable if the site of the fistula was disturbed. The patient has made a satisfactory recovery, but it may be that the ureter and cæcum are still connected by a fistulous tract. Cystoscopic findings seemed to rule out the presence of stone. Whether the fistula resulted from injury at the time of the abdominal operations cannot be determined with certainty.

## PULMONARY ACTINOMYCOSIS

DR. P. A. MCCARTHY, by invitation, reported the case of a woman, aged twenty-eight, who was admitted to the Mental Department of the Philadelphia General Hospital, August 29, 1925, with a diagnosis "manic-depressive insanity." She died March 26, 1926. In September, 1925, there was first noted a small tumor overlying the fifth rib in the right mid-axillary line. The tumor was painless and was attached to the rib. On October 1, 1925, excision was made. A pathological diagnosis of "chronic suppurative inflammation" was made. X-ray of ribs and lungs showed no abnormal findings. The wound did not heal. On November 4 smear from the wound discharge was positive for actinomycosis. On January 2, 1926, she came under the care of Dr. Hubley R. Owen. The patient was extremely emaciated and complained of severe pains in lower abdomen and lower extremities. Over the fifth and seventh ribs mid-axillary line and tenth rib mid-scapula line, were small scars at the centres of each of which was a small sinus exuding a gray glutinous material. The infected tissues were adherent to the underlying chest wall. The neurological symptoms became rapidly more severe, including pain in the abdomen and lower extremities. The left leg became gradually paralyzed. The right leg manifested a progressive weakness; marked hyperæsthesia over both extremities. X-rays of chest and vertebræ negative. Ray fungi were demonstrated from the skin lesions. During subsequent weeks, patient's condition became progressively worse. Pain in lower extremities became so excruciating that she begged for operative interference.

*Operation.*—March 25, 1926, by Doctor McCarthy, after transfusion of 500 c.c. citrated blood. A laminectomy was done involving the eleventh and twelfth thoracic vertebræ and first lumbar. The laminæ of the twelfth thoracic vertebra were very friable and rough. The dura was thickened, densely adherent, very tense and covered with tissue resembling granulation tissue. When the dura was opened, a large quantity of cerebrospinal fluid escaped. The cord was not involved. At close of operation, patient was in fair condition. Death supervened suddenly twenty-four hours later.

At post-mortem: The most marked pathology was found in the right lung, which was infiltrated with fibrous tissue toward its base. In the centre of this fibrous tissue was a necrotic area about size of a walnut containing gray, red glutinous material with flocculent granules. The necrotic process extended down to and involved the diaphragm. This necrotic process also involved

the parietal pleura from the fifth to the tenth ribs and extended along the eighth, ninth and tenth ribs posteriorly and involved the lateral processes and bodies of the vertebrae and the dura. In the necrotic area of the lung, actinomycotic fungi could be demonstrated. No fungi were found in the liver or diaphragm. The brain was negative; spinal cord tracts normal; spinal meninges infiltrated with round cells.

Doctor McCarthy was of the opinion that this case probably originated in the lung and extended by contiguity to the pleura, ribs, skin and vertebrae while the affection of the meninges produced the compression symptoms noted.

Pulmonary actinomycosis is usually not recognized until the chest wall is penetrated and the fungus is found in the discharge. Primary involvement of the nervous system by actinomycosis is rare. Every inflammatory swelling of the thorax wall, subacute or chronic, with persistent and recurring sinus formation, should be carefully investigated for the presence of actinomycosis.

DR. JOHN SPEESE said that during the past winter a girl, seven years of age, was admitted to the Children's Hospital with symptoms suggestive of empyema. The X-ray showed a shadow over the left base which was suggestive of a thickened pleura or fluid. Several exploratory tappings were negative. Finally the chest was opened, no fluid was found, and the sinus which resulted did not heal. It was thought at one time that the child had tuberculosis and the actinomycosis was only recognized when scrapings from the deeper parts showed the fungus. A second exploratory operation revealed the very extensive character of the disease which involved the pericardium and mediastinum; ultimately the child died. The father of the patient was a fruit dealer and the child was accustomed to play about the floor, which contained a great deal of straw. It was believed that the fungus probably gained entrance to the air passages from this infected material.

DR. G. M. DORRANCE remarked that he had seen two cases of actinomycosis during the past year at the Philadelphia General Hospital. One case involved the tongue. The speaker called attention to the fact that this condition is often mistaken for cancer when seen about the jaws or tongue.

#### CARCINOMA OF THE RECTUM

DR. JOHN H. JOPSON presented a woman, twenty-six years old, who was referred by Dr. George Outerbridge to the speaker's service in the Medico-Chirurgical Hospital, suffering from bleeding from the rectum, pain in the lower abdomen, in the middle of the abdomen and in the back. Her general condition was not good. X-ray examination revealed a napkin-ring constriction of the pelvic colon, 5 cm. in width and 8 cm. above the anus. It was patulous to an opaque enema. The pelvic colon was elongated. The patient was subjected to the usual procedure as systematized by Dr. Daniel Jones, of Boston. Recto-sigmoid growths offer a difficult problem and Doctor Jopson believes that this operation offers the best anatomical and physiological approach. The first stage of the operation was done June 1, 1925, and included colostomy, mobilization of the descending colon and peritonealization. The second stage was done June 12 and consisted of removal of the rectum and perirectal tissues from below. Pathological examination confirmed the diagnosis of adenocarcinoma. She was discharged on August 11, 1925, since which time her general health has been excellent. She has returned to her occupation as a secretary and is perfectly well.

## CARCINOMA OF THE RECTUM

DOCTOR JOPSON presented a second patient, a man aged thirty-seven, who was admitted to his service at the Medico-Chirurgical Hospital in March, 1926, complaining of bleeding from the rectum and constipation. The symptoms were of several months' duration and were attributed by the patient to a "strain". A physician had treated him for hemorrhoids, but repeated hemorrhages and an increasing amount of blood finally brought him to a proctologist, who at once recognized the condition as carcinoma and referred him for operation. On admission a mass was felt in the rectum about three inches from the anus. The growth was hard and extended on to the anterior surface. There was considerable constriction present. Introduction of a speculum was followed by escape of gas and mucus.

Except for a fairly severe secondary anæmia, the examination was otherwise negative. Careful examination, including X-ray, failed to show evidence of metastases. Operation was performed in two stages, the first stage on January 11, followed by the second stage in one week. The procedure was the same as in the preceding case, *i.e.*, by the abdomino-perineal method of Jones. The mistake was made in this case of completely cutting off the marginal artery at the first stage, which resulted in gangrene of the lower loop of bowel. The gangrenous process was so extensive that the patient developed a large fistulous tract extending from the abdominal wound into the perineum. The tract was "Dakinized" and healing by granulation took place. A large amount of blood was lost at the operation, which prolonged the convalescence, but the final result was excellent. He was discharged from the hospital on March 22, ten weeks after the first operation.

The speaker believes that it is not wise to attempt closure of the large perineal wound in these cases, but prefers to "Dakinize" and allow healing by granulation. The patient is thus saved much in the way of absorption and fever. This patient has a well-functioning colostomy of the "single-barrel" type, due to the sloughing out of the lower loop. He returned to work on May 22, 1926, and has been working ever since.

Both of the patients presented by Doctor Jopson have had careful and systematic post-operative X-ray treatment at the hands of Dr. George Phaler. Both have the simple form of colostomy, the speaker having found that the more complicated fail to give as great satisfaction.

## PRINCIPLES UNDERLYING THE SURGERY OF CARCINOMA OF THE RECTUM

DR. DAMON B. PFEIFFER pronounced the annual oration on the above entitled subject.

# TRANSACTIONS

## OF THE

# NEW YORK SURGICAL SOCIETY

*Stated Meeting Held March 9, 1927*

The President, DR. WALTON MARTIN, in the Chair

### PROGNOSIS IN GIANT-CELL SARCOMA

DR. WILLIAM B. COLEY presented a group of cases illustrating the cure of giant-cell sarcoma by different methods of treatment. In presenting Case I, one of his earlier series of cases, Doctor Coley remarked that he believed he was one of the first surgeons to advocate the conservative treatment of sarcoma of the long bones, particularly central sarcoma of the giant-cell type.

CASE I.—*Myelosarcoma (giant-cell) of tibia, recurrent; treated by curettage, toxins and X-rays. Patient well twenty-three years later.* K. K., female, aged seventeen years, was referred to Doctor Coley by Dr. V. P. Gibney in October, 1904, with the following history: The patient had been treated at the Presbyterian and the Post-Graduate Hospitals as a case of tuberculous disease of the lower end of the tibia. The leg had been put in a plaster-of-Paris splint in September, 1904; and the patient was unable to walk. A large soft swelling was found over the internal malleolus, with slight effusion into the joint. An operation was performed at the Hospital for Ruptured and Crippled on October 11, 1904, by Doctor Gibney assisted by Doctor Coley. At this time, eight ounces of thick, reddish-brown, soft material was removed from the lower end of tibia. The entire lower third of the tibia was, apparently, involved, and only a thin outer shell remained. The ankle-joint was not involved. A section was examined microscopically, and pronounced myelosarcoma (giant-cell).

On January 3, 1905, a large local recurrence had developed and a second operation (curettage) was performed. The patient was then given systemic toxins combined with X-rays. At the end of five months she was discharged. Regeneration of bone had taken place in the destroyed area of the lower end of the tibia; and the patient had a perfectly useful limb. She remained in good condition, with the exception that, about ten years after treatment, when she developed an ulcer at the site of an X-ray dermatitis, which failed to heal under treatment, and necessitated scraping and skin-grafting. At the present time, twenty-three years later, the patient is in excellent condition with no evidence of a recurrence.

CASE II.—*Central sarcoma of lower end of femur, giant- and spindle-cell, with extensive involvement of the knee-joint, treated with toxins alone. Limb saved. Patient well twelve and one-half years later.* For a more full report of the following case see the ANNALS OF SURGERY, December, 1919. L. G., female, aged nineteen years, was admitted to the Hospital for Ruptured and Crippled on October 24, 1914, with a tumor of the lower end of the femur with extensive involvement of the knee-joint, which had been treated for tuberculosis at various other hospitals. An exploratory operation was per-

## PROGNOSIS IN GIANT-CELL SARCOMA

formed by Doctor Coley but no attempt was made to curette the large tumor. Sections were examined by various pathologists who reported as follows: Mixed-cell sarcoma (Dr. F. M. Jeffries), malignant giant- and spindle-cell sarcoma (Dr. F. C. Wood), sarcoma, malignant (Doctors McCarty and Broder, Mayo Clinic and giant- and spindle-cell sarcoma (Dr. J. Ewing). In a later report, Doctor Ewing stated: "The tumor was not histologically benign; I merely mean it was not extremely malignant." According to the Bone Sarcoma Registry, this tumor was classified as a benign giant-cell sarcoma.

DOCTOR COLEY stated that an amputation was advised but refused by the patient. The toxin treatment was then begun and continued for nearly a year. Immediate improvement was noticed, which continued until complete recovery had taken place. Doctor Coley stated that, regardless of the histological type of the tumor, he does not believe there is another case on record of such an extensive tumor of the femur with involvement of the knee-joint, that has been cured by any method of treatment without amputation.

The later developments in this case are of interest: In the latter part of 1922, a tumor appeared in the right breast and was removed by operation. The clinical and microscopical diagnosis was that of fibro-adenoma. About eight months later, another tumor developed in the same breast at the site of the old scar. This grew with somewhat greater rapidity than the previous tumor, and about three months later, a small nodule, the size of a cherry, appeared one inch above the main tumor and separate from it. This nodule was firm in consistence, but not hard, while the larger tumor was soft, apparently cystic, and resembled a cystadenoma. Both tumors were removed by operation by Doctor Coley. Several sections were submitted to various pathologists who at first found great difficulty in making a diagnosis between carcinoma and sarcoma but who later reported as follows: Sarcoma (Doctor Jeffries); carcinoma (Doctors Ewing and Wood). The macroscopical appearance of the tumor and the rapidity of its growth, associated with the early age of the patient, inclined Doctor Coley to regard it clinically as sarcoma; but in view of the pathological diagnosis he believed the case might be regarded as another example of a rare condition, that is, two different types of malignant tumor developing in the same individual after a longer period of time. The patient is in excellent condition at the present time with no evidence of a recurrence, twelve and one-half years since the time of Doctor Coley's first observation, and three years since the removal of the malignant tumor of the breast. It is interesting to note that only a local removal of the breast tumor was made, and the axilla was not opened. The toxins were given for four months in addition to prophylactic X-ray treatment.

CASE III.—*Giant-cell sarcoma of femur apparently cured by a combination of operative and X-ray treatment. Patient well two years later.* I. H., male, aged thirty-six years, was admitted to the Memorial Hospital on January 9, 1925, with the following history: Patient's family history negative. During the years 1917 and 1918, while in the Navy, the patient fell several times, bruising his left knee. In the winter of 1921, he felt severe pain in the knee; this was relieved by bandage and electric treatment. One year later the symptoms returned and did not respond to the same treatment. He was admitted to Bellevue Hospital where an operation (partial removal of the condyle) was performed by Doctor Hartwell and Doctor Dudley on June 19, 1923. A section was examined microscopically by Doctor Ewing and pronounced benign giant-cell sarcoma. The patient wore a splint for fifteen months. The pain returned and was associated with considerable stiffness and tenderness at the



right knee-joint. At the time of his admission to the Memorial Hospital, an X-ray picture was taken which showed: "The outline of the resected internal condyle of the femur to be irregular, and the appearance suggestive of the presence of active tumor growth in the adjacent medulla and cortex of bone." He was treated with high-voltage X-rays by Doctor Herendeen, six treatments being given between January, 1925, and August, 1925. The pain has entirely disappeared; recent X-ray pictures show further laying down of new bone; and, with the exception of a slight limp, the patient is in excellent condition at the present time, more than two years later.

CASE IV.—*Giant-cell sarcoma of head of tibia, treated by curettage and carbolic acid. Patient well two years later.* N. P., male, aged forty-four years, was admitted to the Hospital for Ruptured and Crippled on April 25, 1925, complaining of pain and swelling about the right knee, which condition was of two years' duration. Examination by Dr. Royal Whitman revealed a tumor about the size of half an orange, situated on the outer and upper side of the tibia extending back to the head of the fibula. There was no interference with the action of the knee-joint. An X-ray picture taken at this time showed a large cystic tumor beneath the head of the tibia; the walls of the tumor were extremely thin; and it apparently communicated with the knee-joint at its outer margin. There was no sensitiveness to pressure. The diagnosis made was that of cystic tumor or a giant-cell sarcoma.

On April 27, 1925, Doctor Whitman made an oblique incision just above the head of the fibula downward and forward for about five inches; the wall of the tumor was thick; when partly removed it opened a cavity communicating with the head of the tibia. This cavity contained yellowish cheese-like masses and reddened grumous tissue both in the sac and in the cavity of the head of the tibia. The walls were not lined with connective tissue, but displayed a roughened and yellowish eroded surface. The knee-joint was opened and all the tissue that remained was the cartilage entirely separated from the bone. The wound was packed. Microscopic diagnosis: Giant-cell sarcoma.

On June 20, 1925, the patient was discharged, wearing a brace, and holding the limb in full extension. The cavity was clean and evidently closing from the bottom. At the present time, nearly two years later, the patient is still in good condition with no evidence of a recurrence.

CASE V.—*Giant-cell sarcoma of femur (clinical and X-ray diagnosis), treated with radium alone; apparent cure. Patient in good condition five years later.* G. M., male, aged twenty-six years, was admitted to the Out-patient Department of the Memorial Hospital on March 27, 1922, with the following history: In January, 1921, the patient slipped and fell, his right leg doubling under him, and resulting in a fracture of the femur. A tumor developed shortly after at the site of the fracture. As soon as the case was removed, swelling and stiffness in the right knee were noticed. In August, 1921, throbbing pain was felt in the knee. Physical examination on March 22, 1922, showed the knee-joint somewhat profusely enlarged, and incapable of being fully extended. The swelling present seemed to be of bony origin. The patient walked with a limp. From the clinical and X-ray evidence, a diagnosis of giant-cell sarcoma was made.

Radium treatment was given by Doctor Quick. From March 8, 1922, to September 11, 1922, the patient received a total of 98,506 mc. hours in the form of a pack placed at 6 cm. distance.

On June 6, 1922, examination showed the leg to be somewhat smaller, and a slight radium burn to have entirely healed. X-ray pictures showed



that the tumor had materially diminished, although there was evidence of further destruction of bone. On August 5, 1922, the patient was admitted for further radium treatment. On January 31, 1923, the X-ray picture showed some improvement, and some increase in calcareous deposit. On March 21, 1923, the X-rays revealed evidence of a fracture through the cortex of the external condyle, head of the tibia and fibula, with little displacement. On November 12, 1924, there was definite evidence of marked increase in ossification of cortex about the tumor. Further X-ray pictures showed a continuation of this ossification. The patient was able to go back to work at about the end of a year, and has been in good condition ever since. Present condition shows slight limitation of motion at the knee-joint, and one inch decrease in the circumference of the leg two inches above the patella, due to atrophy of the soft parts. Over the outer condyle, there is a thick scab formation, about one inch in diameter, due to an X-ray dermatitis; there is no ulceration; no pain; and no evidence of a recurrence of the disease.

The patient remains in good health, five years since the beginning of treatment. Doctor Coley stated that he was indebted to Doctor Quick for the courtesy of showing this patient.

While there was no microscopic confirmation of the diagnosis, Doctor Coley believed that the clinical and X-ray evidence was conclusive that the condition was a giant-cell sarcoma.

CASE VI.—*Giant-cell sarcoma of fibula (clinical and X-ray diagnosis) treated with X-rays alone. Patient well four years later.* T. F., male, aged twenty-eight years, was admitted to the Out-patient Department of the Memorial Hospital on March 29, 1923, having been referred by Dr. C. H. Randall, of Newark, N. J. Nine months before admittance, the patient first complained of pain in the left knee, which was most intense when he tried to walk. This gradually grew worse, and he developed a limp. In July, 1922, he was treated with violet rays for rheumatism. One month later he noticed a swelling at the site of the pain, just below the knee, on the outer side of the left leg. An X-ray picture was taken, and showed a bony tumor originating in the fibula.

Physical examination on March 29, 1923, showed a diffuse swelling occupying the upper third of the left fibula, extending up to within one and one-half inches of the upper end. A clinical and X-ray diagnosis of giant-cell sarcoma of the head of the fibula was made. Doctor Herendeen's report on the stereoscopic plates made at this time is as follows:

"There is evidence of a process in the head of the fibula having its origin in the medullary portion and dilating the cortex equally in all directions; plate presents the features of a giant-cell sarcoma. The soft parts are not invaded; the tumor seems to be still limited by a thin bony capsule. Plate of chest does not reveal evidence of metastasis."

X-ray treatment by Doctor Herendeen was begun on March 29, 1923. The patient was given two exposures, twenty-five minutes each, over the lateral aspect, and one, fourteen minutes, over the left external surface of the head of the fibula. On June 13, 1924, he was given a twenty-five minute exposure to the leg, externally over the tumor.

An X-ray picture taken on June 4, 1924, revealed evidence of further increase in ossification; this process continued as revealed by later X-ray pictures taken on October 17, 1925. The patient was shown at the Memorial Hospital staff conference on March 3, 1927, at which time he was in excellent condition, four years after treatment was begun.

CASE VII.—*Giant-cell sarcoma of lower end of radius, treated by curettage and carbolic acid; a recurrence developed and disappeared under two months' toxin treatment. A second recurrence took place and was treated by heavy radiation for four months. The tumor steadily increased in size and the toxin treatment was resumed, under which, the tumor entirely disappeared and regeneration of bone took place. The patient is well at the present time, seven years later.* M. F., female, aged forty years, was admitted to the Hospital for Ruptured and Crippled on November 28, 1919, with a tumor of the right radius, of four months' duration. This was curetted and the cavity was swabbed out with pure carbolic acid. A section was examined microscopically by Dr. F. M. Jeffries, who pronounced it a giant-cell sarcoma; this diagnosis was later confirmed by Doctor Ewing. A recurrence took place within two months. The toxin treatment was begun and kept up for six weeks, under which, the tumor entirely disappeared. The treatment was discontinued. A second recurrence took place a little over two months later. The patient was then treated with massive doses of radium (a total of 90,000 mc. hours) for a period of four months. During this time, the tumor steadily increased in size, there was no new bone formation, but complete loss of the bony shell. In October, 1920, an amputation was considered, but Doctor Coley decided to give the toxins a further trial. This treatment alone was given for the next four months. Immediate and steady improvement was noticed, with gradual regeneration of new bone filling up the area that had been destroyed by the tumor. The treatment was discontinued in February, 1921, and the patient was discharged. Complete restoration of function took place, there was no further recurrence, and the patient remains in excellent condition at the present time, seven years later.

CASE VIII.—*Sarcoma of the lower end of radius (clinical and X-ray diagnosis was that of giant-cell sarcoma) with complete destruction of the bony shell; treated with systemic toxins. Regeneration of bone took place, and the patient is in good condition, with a useful arm, nine years later.* L. D. G., male, adult, was admitted to the Hospital for Ruptured and Crippled on April 25, 1918. Examination showed complete destruction of the lower three inches of the radius by a tumor that had broken through and completely destroyed the outer shell of the bone; a pathologic fracture had taken place. Amputation had been advised by the other surgeons, and the patient was referred to Doctor Coley by Dr. V. P. Gibney. Doctor Coley decided to try the toxins alone without biopsy as the diagnosis was quite clear, and the treatment was begun at once. At the end of three months, the tumor had entirely disappeared; regeneration of bone had begun to take place, with gradual restoration of function. The patient continued to improve; and at the present time, nine years later, he is in excellent condition with no evidence of the disease remaining.

In this case, the clinical and X-ray diagnosis was that of central sarcoma of the radius, probably giant-cell sarcoma.

The X-ray pictures taken a year after treatment showed almost complete regeneration of the diseased bone and the formation of a new lower end of the radius. The period of treatment and the duration of disability in this case was made shorter than in the cases treated by radiation.

CASE IX.—*Sarcoma (endothelioma type) of fibula with extensive metastases in the groin, iliac fossa and lung; treated by amputation, systemic toxins for four months and one radium-pack treatment to iliac fossa (none to lung). The patient is in good health, with no evidence of the disease, seven years*

*later.* H. S., male, aged eight years, had always been in good health until January, 1920, when he was struck on the outer side of the right leg, at which site pain and swelling developed shortly afterwards. The swelling continued to increase in size and the patient, in March, 1920, was admitted to the Hospital for Ruptured and Crippled, where he was operated upon by Dr. Royal Whitman. The clinical and Röntgen-ray diagnosis was osteomyelitis. Exploratory operation showed some pus and marked thickening of the bone. This was extensively curetted, and a section examined microscopically and pronounced periosteal round-cell sarcoma.

When Doctor Coley first saw the patient, in consultation, in June, 1920, the lower two-thirds of the fibula was occupied by a large tumor, apparently of periosteal origin, fungating in the central portion; the glands in the groin were enlarged, one being about the size of an English walnut. Doctor Coley advised immediate amputation to be followed by prophylactic toxin treatment. Amputation was performed by Dr. Armitage Whitman, and the patient then given toxins under Doctor Coley's direction. A section of the amputated specimen was examined microscopically by Dr. F. M. Jeffries, who pronounced it a round-cell sarcoma of periosteal origin. Doctor Ewing also examined a section and classified it as endothelioma. A gland of the groin was removed in July, and on microscopical examination was pronounced round-cell sarcoma or endothelioma. The toxin treatment was kept up until mid-August, when, on account of the excessive heat, the patient was permitted to return home. Reëxamination on October 23, showed the inguinal glands to have increased in size; in addition there was a hard mass, the size of a child's head, in the right iliac fossa, evidently involving the retroperitoneal glands. X-ray examination of the chest by Doctor Herendeen showed well-developed, unquestionable metastases of the lung. On October 27, the patient received a radium-pack treatment (10,109 mc. hours at 7 cm. distance) over the iliac fossa. The case was regarded as hopeless and all treatment was discontinued.

In the early part of May, 1921, the patient's father reported that the boy was in excellent health and was attending school regularly. He was examined at the Memorial Hospital on September 19, 1921, at which time there was no evidence of a tumor in the abdomen or groin, and an X-ray picture of the chest failed to show any evidence of the metastasis that had been present in the preceding October. The patient was shown at a clinic held during the meeting of the American College of Surgeons in October, 1924. He is still well with no evidence of the disease, seven years later.

This case Doctor Coley presented to show that in certain cases of the most malignant type of sarcoma of the long bones, soon after extension metastases have developed, tumors may be made to disappear under the system action of the toxins of erysipelas and B. Prodigiosus and the local action of radium and the patient pronounced cured.

DR. JOHN A. HARTWELL, referring to the case presented by Doctor Coley on which Doctor Dudley had previously operated, said that all the growth had been cleaned out. As to whether there had been a recurrence he was uncertain. It was difficult on the evidence of the films to say whether there had been regeneration of bone or a reappearance of the tumor. At the Bellevue X-ray Laboratory it was considered to be a recurrence. There is a great deal of confusion in these cases because of the variations in patho-

logical reports and the X-ray findings. It is often uncertain what one is dealing with, and when Doctor Coley presents evidence that giant-cell tumor of bone may be malignant, one cannot help questioning whether this is the same giant-cell tumor that is known to be non-malignant; particularly when it is shown that there has been considerable difference of opinion between able pathologists who have passed on the sections. The histological evidence of what they are is difficult of interpretation. When we find a tumor that responds to radiation and the injection of toxins and disappears, and when we find apparently the same tumor not yielding but producing metastasis, one cannot help wonder if we are dealing with the same process. Doctor Hartwell thought it was to be regretted that Doctor Coley did not always use the term Giant-cell Tumor, which he did occasionally in his paper while in other places he used the term Giant-cell Sarcoma. It is a tumor and contains giant cells. Therefore the designation adopted by many who have discussed it as giant-cell tumor shows what it is. When it is called giant-cell sarcoma there is an implication that it is malignant, and when in addition it is referred to as benign, one cannot help but feel that the term given it is a misnomer. If Doctor Coley would call them giant-cell tumors there would be less confusion in the minds of those who know so much less about the disease than Doctor Coley does.

DR. JOSEPH WIENER said that the remarks of the previous speaker led him to report a case which is apropos to the question whether the X-rays show regeneration of bone or new growth. The patient had had three pathological fractures and was sent to a bone surgeon with an X-ray diagnosis of new growth. A room was engaged at the hospital and the surgeon arranged to do an arm amputation. Doctor Wiener came back from his vacation and saw the plates and examined the patient and expressed his belief that the operation was not necessary as he did not believe there was a new growth present. The operation was postponed and a long series of X-ray pictures were taken here in New York and in Baltimore, and meantime Doctor Wiener treated the patient for the pathological fracture at the lower end of the humerus, but used no radium, no X-rays nor toxins. That was six years ago, and when Doctor Wiener saw the patient last summer he had remained perfectly well. There is often doubt if one is dealing with new bone or a new growth and the speaker never accepted unqualifiedly a radiological diagnosis. He thought this was too often done. Another point Doctor Wiener brought out was the importance of microscopic diagnosis before concluding there was a new growth. There was a case of supposed tumor of the fascia lata admitted to Mount Sinai Hospital, diagnosed as sarcoma, a young woman eighteen years of age. This patient was treated with toxins for five months and the tumor became much smaller. At operation the growth was found to be a lipoma. The clinical diagnosis was sarcoma of the thigh; the tumor was as big as two fists. Had the tumor not been removed it would have been put down as sarcoma of the thigh ultimately cured by toxins.

## PROGNOSIS IN GIANT-CELL SARCOMA

DR. WILLIAM CRAWFORD WHITE said that two years ago he had a patient, a young girl, with a pathological fracture of the humerus. The X-ray diagnosis was giant-cell cyst of the diaphysis. Doctor White showed the plates to two or three of his associates who advised him not to operate as there was a definite feeling at that time that X-ray diagnosis was sufficiently accurate and that anyway the condition could be cured with radium or X-ray therapy. Doctor Blake considered it a giant-cell tumor and advised curetting and putting in a little fat. Nevertheless, Doctor White operated. It turned out to be tuberculosis. The patient is now well.

DR. CONSTANTINE J. MACGUIRE, JR., said that three or four years ago, in collaboration with Doctor McWhorter, he collected data regarding some fifty cases from which sections had been examined. Twenty of these were giant-cell tumor and of those twelve were definitely benign. They all ran a straight course and responded to curettage. Of the remaining eight, five recurred locally but without metastasis. That left three. One was the J. S. that Doctor Bancroft spoke of. One was a giant-cell sarcoma, showing giant cells in the section and typical trabeculation. This case was followed for twelve years and backed up the theory of the possibility of a giant-cell tumor becoming malignant. The tumor began to invade the knee-joint and, subsequent to curettage with fat transplant, there was local recurrence. That recurrence showed a mass of spindle cells with no giant cells at all. Amputation was done and there was no further recurrence. A change in the histological picture does often occur, but the speaker did not believe that giant-cell tumors were 20 per cent. malignant. These giant-cell tumors are surgical curiosities; they are different from sarcoma of the bone. If one occurs anywhere near the head of the humerus and it is called a giant-cell growth, one will have to prove it. The speaker did not believe there is any common therapeutic agent that will cure these benign tumors and the malignant ones also.

There was one other point in regard to therapy in giant-cell sarcoma that Doctor MacGuire brought out. They do not as a rule bother the patient unless there is a pathological fracture or limitation of motion in the neighboring joint; the speaker had never seen these factors improved by toxins, radiation or surgery. One can get the production of dense cortical bone around the space by radiation, but the patient is no better off than before. Then, too, how is a pathological fracture going to be cured by toxins or radiation? In five cases of curettage general sepsis resulted and amputation had to be finally done. This danger of infection of the knee-joint after curettage of tibial and femoral lesions is very real and common enough to make one hesitate to curette the larger giant-cell tumors near the knee.

DR. DEWITT STETTEN said he felt that one of the important facts gleaned from Doctor Coley's paper was that giant-cell tumors occasionally are or become malignant. The speaker said he would like to place on record a personal observation of another such case, in addition to those mentioned by Doctor Coley. The patient in question was originally operated on by

Dr. Frederic Kammerer at the Lenox Hill Hospital some fourteen years ago. He was an elderly man with a giant-cell tumor at the lower end of his left femur. A conservative operation was performed, the tumor being thoroughly curetted out. The tumor recurred locally in about three months and it was again curetted. Some six months later the man came under Doctor Stetten's care with diffuse pulmonary metastases, from which he died.

DR. WALTON MARTIN said that the case of M. C., to which Doctor Coley had referred, has created considerable discussion. Doctor Wood believed, from the appearance of the slides, that it was a malignant growth and advised amputation. From the appearance of the tumor and the X-ray the speaker thought it was a giant-cell tumor and advised radiation after curettage. The boy suffered a great deal of pain following the application of radium and recurrence followed. Doctor Coley amputated the leg and the boy died from metastasis as he has related. Doctor Ewing thought from the appearance of the slide that it was benign. Doctor Wood thought it was malignant. The interesting feature to him, Doctor Martin said, were the different opinions given by two equally distinguished and experienced pathologists regarding the nature of the growth as judged by microscopical examination. It is not always easy to tell from the pathological sections the nature of these growths.

DOCTOR COLEY, in closing the discussion, replied to Doctor Hartwell that, the reason why he does not use the term giant-cell tumor, is, because he believes that these so-called giant-cell tumors are really a type of sarcoma. Doctor Coley stated that this question of terminology was thoroughly discussed by one of the highest authorities on the subject, Dr. Matthew J. Stewart, Professor of Pathology at the University of Leeds, in his paper on "The Histogenesis of Myeloid Sarcoma" (*Lancet*, November 25, 1922), in which the author asserted that these tumors are essentially sarcoma, albeit of only local malignancy in the great majority of cases, and that the giant cells are not fortuitous but a constant and integral part of the growth. With this view, Doctor Coley stated, he was in entire accord. Furthermore, he pointed out the fact that Doctor Ewing, of New York, in his classification of these tumors, divides them into three groups, viz., benign, borderline and malignant.

Doctor Hartwell said he thought there were two different kinds of giant-cell tumors; and he asked how one was to decide the question. The case to which Doctor Martin referred seemed to well illustrate this difficulty. In this case the tumor was pronounced a giant-cell tumor of possible malignancy by Doctor Wood, who advised an amputation. According to Doctor Ewing, it was a benign giant-cell sarcoma of the epulis type, and presented a favorable prognosis. Doctor Bloodgood's diagnosis was benign giant-cell tumor. The patient was treated by curettage and heavy radiation; a recurrence took place, and the limb was amputated; shortly after this, pulmonary metastases developed and proved fatal. This case well shows that in certain cases the most experienced pathologist is unable to distinguish between the benign and malignant types of giant-cell tumor.

DOCTOR COLEY expressed the belief that giant-cell sarcoma is an infectious disease due to some unknown form of microörganism; and that the different clinical types (benign and malignant) may be accounted for by a variation in the virulence of the organism or in patient's power of resistance to overcome this infectious organism. In some patients, the power of resistance is sufficient to hold it in check and keep it from spreading beyond its original site; in which case we have a benign type of giant-cell sarcoma of only local malignancy. In other patients, the virulence of the organism increases or the power of resistance, for some unknown reason, becomes lessened, and after a certain period of time, the tumor becomes more highly malignant and metastases develop.

In regard to Doctor Wiener's case of lipoma treated with the toxins, Doctor Coley stated that, if Doctor Wiener would look up the records he believed he would find that Doctor Coley had never seen the patient; and that, even if he had, the fact that it turned out to be a lipoma had no bearing whatever on the question of the successful use of the toxins in bone sarcoma.

To Doctor MacGuire's statement that he could not see how the same therapeutic agent could cure these benign tumors and the malignant ones also, Doctor Coley replied that it was to answer this very question that he presented before the Society this evening the second case: a highly malignant periosteal sarcoma of the fibula (of the endothelioma type) with extensive metastases in the groin, iliac fossa and chest, that had recovered under toxin- and radium-treatment, and the patient had remained well for seven years. Doctor Coley stated he could cite many other cases in further proof of this point. Doctor MacGuire had asked how a case in which a pathological fracture had occurred could be cured by toxins or radium. To which Doctor Coley replied that, of the group of patients presented this evening, in three a pathological fracture had occurred; that two of these patients had been treated by toxins, and that all were alive and well, with a useful limb at the present time from five to thirteen years.

Finally, Doctor Coley stated that the main object of his paper was to attempt to clarify the great difference of opinions which now existed, as to the proper treatment of giant-cell sarcoma of the long bones. Doctor Coley stated that, while a number of these cases could be cured by surgery, by radiation or by toxin treatment, that a certain number of relapses would follow the use of any one of these methods of treatment; and that he believed the number of cures could be increased and the number of relapses diminished by a combination of surgery, thorough curettage, with systemic toxin treatment, used alone or in conjunction with local radiation. Doctor Coley stated that the advantage that this method had over radiation alone was that it required a shorter period of treatment with a correspondingly shorter period of disability. Doctor Coley stated that, in his experience, in not more than seventy-five per cent. of the cases was it possible to make a positive diagnosis of giant-cell



sarcoma of the benign type, from the clinical and Röntgen-ray evidence alone. Hence, if all cases were treated primarily by radiation alone, a considerable number of lives would be lost, for the reason that when the fact that the tumor was malignant was finally recognized, it would probably be too late to save the patient.

*Stated Meeting Held March 23, 1927*

DR. JOHN DOUGLAS in the Chair

### PURPURA AND ACUTE APPENDICITIS

DR. MORRIS K. SMITH presented a man who was first admitted to the medical service of St. Luke's Hospital, March 4, 1922, complaining of epigastric pain, vomiting, supra-orbital headache and chill. He had been ill two days. The only thing of note in his past history was several attacks of colitis. He was at the time of admission thirty-two years old. There was generalized abdominal tenderness most marked in the epigastrium with slight distention. The temperature was 102, pulse 124, white blood count 34,000 with 85 per cent. of polymorphonuclears. The red cell count and hæmoglobin were normal.

The next day intermittent epistaxis and melena were noted on the chart. On successive days subconjunctival and a few subcutaneous hemorrhages were observed. The platelet count was 50,000, bleeding time 3 m., coagulation time 7 m. Two weeks after admission the red blood count had fallen from normal to 2,000,000 and the hæmoglobin to 38 per cent. In the meantime he had been very ill, at times irrational and incontinent. As an indication of the abdominal condition it is noted that soft solid diet was first allowed twelve days after admission.

As the patient had had several packings of the nares on account of bleeding it is not strange that he developed an otitis media. Streptococcus hæmolyticus was cultured from the pus. A mastoiditis followed and one month after admission he was transferred to the ear service, where mastoidectomy was done, followed by uneventful convalescence. The diagnosis made on transfer from the medical service was purpura hæmorrhagica.

During the ensuing months he gained weight and felt very well. In October, six months after the first admission, he was readmitted with lobar pneumonia. During this stay he had a few gastric symptoms and two weeks after discharge returned for his third admission with the complaint of pain in the epigastrium, coming on at irregular intervals in the day and relieved by vomiting. Although gastro-intestinal series and Ewald test-meal were negative, he was discharged with the diagnosis of probable gastric ulcer.

The next admission was to the surgical service in May, 1923, fourteen months after his first admission. The history at this time was pain across abdomen of two days' duration, localizing in the right lower quadrant, accompanied by nausea and vomiting. There was tenderness and rigidity in the right lower quadrant, the temperature on admission was 100, the white blood count 8000 with 76 per cent. of polymorphonuclears. On account of the past history of this patient operation was deferred in the belief that the abdominal symptoms might be a purpuric manifestation. The next day the blood count had risen, the platelet count was 156,000. The abdominal signs were so definite that the diagnosis of appendicitis seemed clear. At operation a perforated gangrenous appendix was removed. Drainage was necessary. He was discharged on the seventeenth day.

Two weeks later he was readmitted to the medical service on account of



## DIAPHYSEAL TUBERCULOSIS

vomiting. The appendectomy wound was healed. There was no tenderness nor mass. No purpuric spots nor hemorrhage were noted. He was discharged well after two and one-half weeks, and has remained well ever since, now nearly four years.

The interest in this case centres in the differential diagnosis between purpura with visceral manifestations and appendicitis. Purpura hæmorrhagica is defined by Minot and Lee in Nelson's Loose Leaf Medicine, "As that condition associated with marked diminution of the blood platelets in which there is spontaneous bleeding from some mucous membrane, usually with purpuric skin lesions." There may be gastro-intestinal manifestations. It may be idiopathic or secondary to toxæmia of some sort. Among other forms of purpura than purpura hæmorrhagica, idiopathic purpura with visceral manifestations, the so-called Henoch's purpura, must be considered. In this condition, however, the platelets are not ordinarily notably diminished. The diagnosis of purpura hæmorrhagica made on the first admission agrees with all the findings in this case and the question remaining is whether it was of idiopathic origin or secondary to a sepsis of appendiceal origin. In view of the subsequent history it seems quite possible that he had acute appendicitis in the first instance to which the purpura was secondary.

DR. FENWICK BEEKMAN said that some years ago a child was admitted to the Children's Surgical Service at Bellevue Hospital having been sick for two days with vomiting and passing large amounts of bright red blood and mucus in the fæces. Physical examination showed the abdomen to be slightly distended with a large mass in the epigastrium. Operation was done and a large hemorrhage in the mesentery of the jejunum was found. This mass and the hemorrhage from the rectum had led to the diagnosis of intussusception. The following day the skin of this child was covered with petechiæ. Again, one year ago, Doctor Beekman said he saw a child who had arthritis and his physician had been treating him for acute rheumatic fever. On visiting him one day he found the child vomiting, the abdomen rigid and tender and called Doctor Beekman in consultation. There were petechial spots on the skin of the body. The following morning the abdominal symptoms had lessened but other joints were involved. The condition eventually cleared up with the use of salicylates.

## DIAPHYSEAL TUBERCULOSIS

DR. MORRIS K. SMITH presented a child, eight years of age, who first came to the Out-patient Department of St. Luke's Hospital in November, 1919, when she was sixteen months of age. At nine months she had had diphtheria followed by bronchitis. About this period a swelling of the left side of the jaw and the left forearm appeared. It was on account of these swellings, then of seven months' duration, that she was brought for treatment. There was no superficial inflammatory condition. X-ray of the forearm revealed the appearance of a cyst of the ulna in the upper half. Wassermann was negative.

At a visit a month later it was noted that the right elbow was slightly swollen.

She was not seen again until four months later. The swelling in the left forearm had been drained a short time before by an outside physician. There

was an inflammatory focus just above the right elbow and a second over the occipital bone of the skull which were pointing and were incised. A fluctuant swelling over the left malar bone was aspirated and the pus put in a guinea-pig who developed tuberculosis. A few days later the focus in the left side of the mandible broke into the mouth.

She was then admitted into the hospital. He curetted all the foci with the exception of the occipital obtaining small sequestra from those of the ulna



FIG. 1.—L. S. Tuberculosis of shaft of ulna in 1920.

FIG. 2.—Same as Fig. 1, seven years later.

and humerus. She ran temperature for about two months. The pathological diagnosis was tuberculous osteomyelitis.

Thereafter she was treated as an Out-patient. Sequestra were occasionally extruded. In October, 1922, about three years after she originally presented herself, it was first noted that all wounds were healed. One or another opened occasionally until a year later, since when all sinuses have remained closed. The duration of the disease from the first appearance of the swelling when she was under a year of age until dressings could be permanently discontinued was between four and five years. The child is now eight.

The reporter questioned whether curetting the various foci in this patient contributed much to the ultimate good result, although it was inevitable that the foci should have been drained. It is conceivable that the focus in the left ulna could have been radically removed when she first applied if the diagnosis had been clear at that time. He could not believe that the end result would have been better in the case of this particular bone and as there were already other foci to which a radical removal was not applicable, it does not seem as if it would in any event have been wise. The credit of the cure in this case must be given to the mother who faithfully kept the child outdoors.

## TUBERCULOSIS OF TENDON SHEATH

He presented this patient for two reasons: First, on account of the relative infrequency of diaphyseal tuberculosis in this country, and second, as an instance of complete restoration to health in a child presenting tuberculosis of the ulna, humerus, mandible, malar and occipital bones.

### LOOSE BODY IN INTERPHALANGEAL JOINT

DR. MORRIS K. SMITH presented a young woman. About a year before applying for treatment in January, 1926, she struck the end of her right index finger against a projecting object as she was going down stairs. Since that time the finger has been swollen and painful on use. On examination there was a moderate spindle-shaped swelling centring at the proximal interphalangeal joint, which was sensitive. Flexion at this joint was somewhat limited. At times a click could be demonstrated. X-ray was negative.

Under parigital anaesthesia a lateral incision was made over the joint. On incising the capsule a relatively large amount of the joint fluid escaped and a sliver-like firm body, one-third of a centimetre in length, popped out. It was free except for an attachment at one end to the inside of the joint. Doctor Smith thought at the time that it must represent a fragment of cartilage torn loose at the injury from which the condition dated. The pathological report was, however, chronic inflammatory fibrous tissue. There was no question, nevertheless, but that it acted as a loose body in the joint. Improvement dated from the time of intervention and the patient has a satisfactory result.

Loose bodies in larger joints, particularly the knee, are common enough, but he could not recall having seen reference to such a condition in a finger joint. This case is therefore presented to illustrate the fact that a loose body may occur in a finger joint as an apparent result of trauma, that it can cause disability, and that its removal will cure the condition.

DR. HUGH AUCHINCLOSS asked Doctor Smith if he did not think this body might be a fragment of one of the glenoid ligaments. Personally, he thought this might be so, although he had never seen one free. He asked Doctor Smith if he remembered whether the body came from the front or the back of the joint. There are really glenoid ligaments in the back as well as the front of the joint. The front is considerably larger.

DOCTOR SMITH said that when he operated on the patient he thought this body looked like a fragment of cartilage. The pathological report, however, was fibrous tissue. Incision was made along the lateral side of the finger and as soon as the opening was made this little body popped out. It was attached by one end. Doctor Smith did not remember whether it came from the front or the back of the joint, but he thought Doctor Auchincloss's explanation might be the correct one.

### TUBERCULOSIS OF TENDON SHEATH OF INDEX FINGER

DR. MORRIS K. SMITH presented a woman who came to him for treatment for a swelling of the proximal two-thirds of the left index finger. It involved the flexor side most prominently where it was cystic, but extended on the dorsum where there were nodular elevations, and into the palm for about 2 inches. She was unable to flex the proximal interphalangeal joint

on account of the swelling. The finger was not at all painful and did not appear to interfere particularly with her use of the hand. The duration of the condition was five years. She has never been ill.

At operation, February 23, 1927, she was found to have a tuberculous teno-synovitis of the sheath of the index finger which involved also the extensor tendon of the finger below the knuckle. The process was hygro-matous with numerous rice bodies. Pathological examination confirmed the diagnosis. The case presents an uncommon location of primary tuberculous teno-synovitis. In his limited experience of this disease in the hand, hitherto it has been found in the palm or dorsum.

Kanavel in S., G. and O., for November, 1923, reports fourteen cases of tuberculous teno-synovitis of the hand. There was one in which six years after operation a development of the infection in the index finger sheath appeared. He does not mention any primary isolated finger sheath involvement.

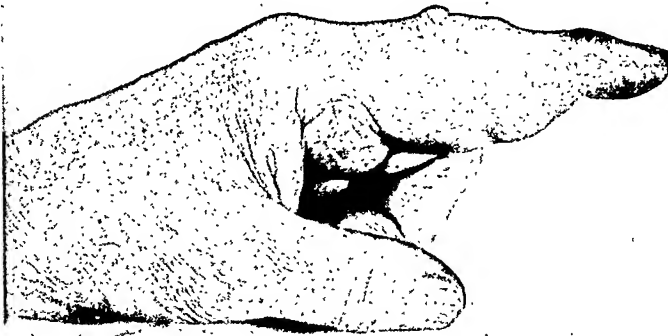


FIG. 3.—Tuberculosis of tendon sheath of index finger.

Dr. Hugh Auchincloss said he had seen a few of these cases and remembered operating on three or four. There are certain things about them that are interesting. One is the degree of motion these patients have when tuberculosis is confined to the digital sheath. They may not be tightly contracted at all. The other point of interest is that all of these patients told a story of long-existing swelling, moderate disability, and pain or discomfort, particularly on excessive use. They did well following complete excision of the sheath. Although this is tedious to do, and one should preserve annular bridges to provide pulleys for the tendons, it is well worth while, for it gives increased function very soon. Doctor Auchincloss had seen two of his cases after several years and they have not had recurrence. Tuberculosis of the tendon sheath of a finger is of course not as common as that of the radial or ulna bursa.

### CONGENITAL STENOSIS OF THE DUODENUM

Dr. Richard W. Bolling presented a five months' old female infant who was referred to him by Doctor Lowenthal in October, 1926, when she was two weeks old. The history was of vomiting since birth, projectile at times, and the vomitus was usually bile-stained. The stools, at first typical meconium, subsequently contained small amounts of curds. Röntgenograms

## CONGENITAL STENOSIS OF DUODENUM

by Doctor Goldfarb showed almost complete obstruction of the duodenum with great dilatation of the proximal segment. The baby appeared to be in very poor condition and weighed six pounds, a loss of one and one-half pounds since birth. The abdomen was not distended and there was a definite purulent discharge from the umbilicus. She was admitted to the Babies' Hospital, transfused with 80 c.c. of blood and operated on. The stomach and pylorus were found dilated and there was an enormous dilatation of the

duodenum extending into the third portion. The cause of the obstruction was not demonstrated. The remainder of the small intestine was collapsed. The jejunum, about 3 cm. distal to the flexure, was applied to the anterior wall of the third portion of the duodenum and an anastomosis effected by means of three rows of interrupted and continuous fine silk sutures. A stoma about 1 cm. in length was formed. Convalescence was relatively uneventful with slight vomiting and some wound infection. The baby was discharged twenty-three days after admission in good condition, having gained 670 grams. To illustrate the anatomical condition a specimen that was removed at autopsy on a similar case is shown. (Fig. 6.) The baby now is five months and ten days old and weighs sixteen pounds. Doctor Bolling presented this

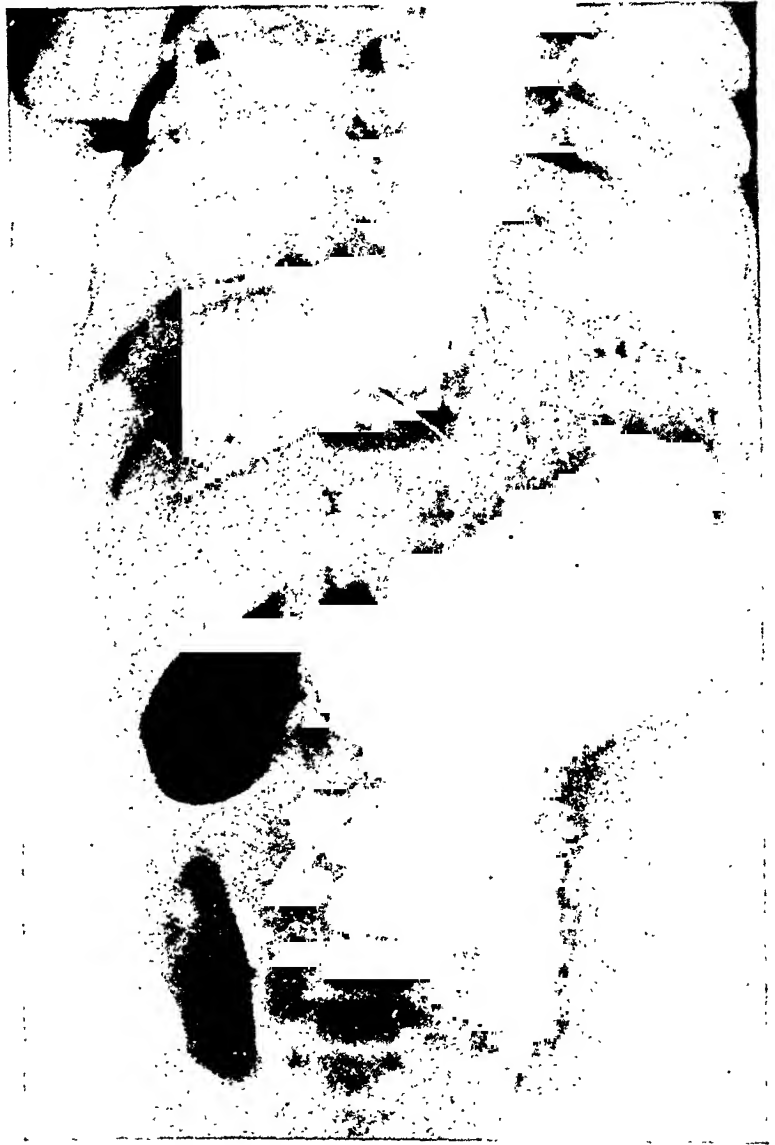


FIG. 4.—Congenital stenosis of duodenum at two weeks. Röntgenogram after opaque meal.

patient to emphasize the very real importance of a röntgenographic examination in babies who vomit from birth. The procedure is simple and harmless. He presented a similar case before this Society in December, 1925. In that instance the obstruction was complete. That child is now seventeen months old and weighs twenty-five pounds.

DR. EDWARD W. PETERSON said that he had operated upon a two weeks' old infant for stenosis of the duodenum. The obstruction was due to a diaphragm which involved about half the lumen of the gut. An operation similar to the Horsley pyloroplasty gave a very satisfactory opening. Unfortunately, however, the infant died a few hours after the operation.

## STREPTOCOCCUS PERITONITIS

DR. RICHARD W. BOLLING presented two patients together in whom the clinical features and pathological conditions were almost identical. The first patient, Margaret, came under his care at St. Luke's Hospital in February, 1926. At that time she was six years old and had been ill five days. At first she had been constipated and had been given several cathartics. On the



FIG. 5.—Same case as Fig. 4, five months after duodeno-jejunostomy. Röntgenogram after opaque meal.

second and third days of her illness she had a chill and high fever. At this time she was thought to have pneumonia. On the day before admission there was severe abdominal pain, at first general and later localized in the right lower quadrant. Vomiting was frequent and persisted throughout the day. On the afternoon of the day of admission there were repeated foul, watery stools. On admission the child appeared acutely ill, the abdomen was moderately distended, resistant throughout and there was right rectus rigidity. Tenderness was general but most marked in the right lower quadrant. The temperature was  $101.4^{\circ}$  on admission but rose to  $104^{\circ}$  immediately before operation. The leucocytes were 23,800, polymorphonuclears 84 per cent. The diagnosis was

acute appendicitis with spreading peritonitis. On opening the peritoneal cavity there was thin, turbid fluid containing numerous flakes of fibrin. The appendix appeared oedematous and congested. This was also true of the adjacent cæcum. The appendix was removed and the wound closed without drainage. The peritoneal exudate gave a pure culture of streptococcus hæmolyticus. The pathological report was acute appendicitis. The report in full was as follows: Macroscopic examination. Appendix 4.8 cm. long, opened in operating room. Serosa a little dull but not hemorrhagic and mucosa and other coats appear normal. Microscopic examination. Sections show an acute inflammation with extensive lymphoid infiltration in all coats, organizing adhesions on surface in which there are also many polymorphonuclear cells and a fairly well-preserved mucosa, although the small vessels in it and the submucosa contain a very large number of polymorphonuclear cells."

## STREPTOCOCCUS PERITONITIS

Doctor Bolling did not believe the appendix to be the source of the peritoneal infection. Twelve hours after operation the child appeared in extremis, cyanotic, pulse rapid, thready, and with a temperature of  $105.4^{\circ}$ . Blood transfusion of 200 c.c. was followed by a most dramatic improvement and two days later when the condition again seemed precarious a second transfusion of 180 c.c. was again followed by marked improvement. Following this convalescence was complicated by wound infection and the development of a secondary abscess in the left lower quadrant which necessitated drainage. She was discharged in good condition sixty-two days after admission.

The other patient, Ellen, came under his care at St. Luke's Hospital in May, 1926. She was six years old and had been ill five days. During this entire period she had suffered from abdominal cramps and high temperature, for two days there had been nausea and vomiting. On day of admission pain was referred to the right lower quadrant. There had been two similar attacks two and three years previously and she had recovered from an attack of measles one month before. On admission the child appeared acutely ill, abdomen slightly distended, resistant throughout and slightly more tender in the right lower quadrant. Temperature was  $104.4^{\circ}$ , pulse rapid and thready, leucocytes 30,900, polymorphonuclears 80 per cent.. A diagnosis of diffuse peritonitis, probably due to streptococcus or pneumococcus infection was made, but as an acute

appendicitis could not be ruled out an exploratory operation was done. The peritoneum was congested and its cavity contained thin turbid fluid. The appendix appeared normal save for the congestion of its peritoneal coat. It was removed. The peritoneum was closed and the wound in the parietes was closed to a rubber dam drain. The peritoneal exudate gave a pure culture of streptococcus hæmolyticus. The pathological report of the appendix was peri-appendicitis. The convalescence was almost identical with that of the preceding case save that only one transfusion of 250 c.c. was given. A secondary abscess in the left lower quadrant was drained on the twelfth post-operative day and the patient was discharged in good condition thirty-three days after admission. These two patients are presented to emphasize the value of the transfusion in acute infections. The procedure seems to be of particular value in infants and children.

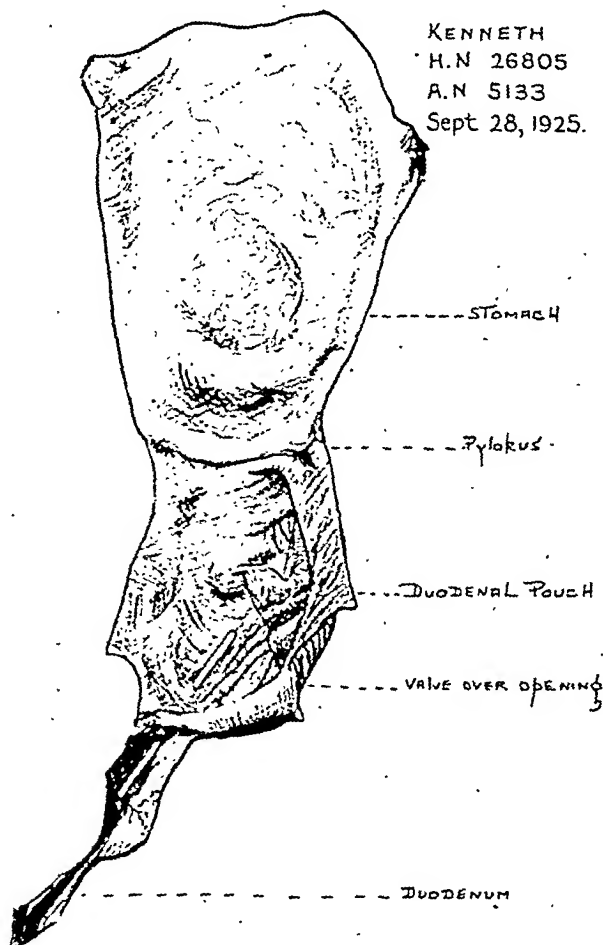


FIG. 6.—To illustrate pathology of case shown in Figs. 4 and 5. Specimen removed at autopsy in similar case.

DR. EDWARD D. TRUESDELL stated that he had two cases of streptococcus peritonitis in children under his care at the present time. Both of these were little girls, ages two and four. One of these cases was undoubtedly going to die; the other appeared to be on the way to recovery one week after operation.

The peritonitis in the case doing badly was secondary to a streptococcus cellulitis in the region of the vulva. There was a positive blood culture, with very high temperature and marked prostration.

In the case progressing toward recovery the peritonitis apparently had its origin in a pharyngitis with enlarged nodes in the neck. In this case three blood cultures were negative, the temperature was not so high and the intoxication was not sufficient to cause prostration.

In both cases exploratory laparotomy was done and cultures made. The appendix in each case was obviously innocent and not removed. Both cases were drained.

DR. FENWICK BEEKMAN said that during the last six years on the Children's Surgical Service at Bellevue Hospital, there had been nineteen cases of primary peritonitis in children, fourteen of which were of pneumococcic origin and five streptococcic. All the streptococcus cases died and they were all in boys. Some years ago Rabinowitz published a series of cases of streptococcus peritonitis, eight in all, and seven were girls.

DR. EDWARD W. PETERSON has under his care on the Babies' Ward of the Post-Graduate Hospital at the present time an eight-year-old boy, who had been under treatment on the medical side for nephrosis. There was general anasarca. There was considerable fluid in the abdomen, and the cedema of the face, scrotum, and extremities was marked. Suddenly the boy began to complain of severe abdominal pain and to vomit, and the temperature rose to 104°. Examination was somewhat difficult, owing to the ascitic fluid, but as the pain was chiefly on the right side, a tentative diagnosis of acute appendicitis was made and operation advised. At operation a large amount of turbid fluid containing lymph flakes was evacuated from the abdomen. The appendix was somewhat injected but was not responsible for the peritonitis. The abdominal fluid showed pure culture of streptococcus hæmolyticus. Within twenty-four hours after operation the general anasarca had disappeared entirely and there followed a condition of extreme tissue dessication. The child was *in extremis*, not responding to the usual measures employed to overcome the dehydration. A blood transfusion was given and, just as in Doctor Bolling's case, was followed by the most magical improvement in the patient's general condition. During convalescence a pneumonia developed, but at the present time the boy has entirely recovered from his peritonitis and his pneumonia. There is a slight tendency, however, for the kidney condition to revert to its former status.

#### PERFORATED DUODENAL ULCER. CLOSURE BY IMPLANTATION OF GALL-BLADDER

DR. RICHARD W. BOLLING presented a man, forty-two years of age, who was admitted to the medical service at St. Luke's Hospital, February 24 of



## CARCINOMA OF SPLENIC FLEXURE OF COLON

this year, with a diagnosis of duodenal ulcer. His hæmoglobin was 55 per cent. and his red cells 3,000,000. On the morning of the third day after admission he complained of severe abdominal pain. The diagnosis of perforated ulcer seemed fairly definite and he was operated upon at once. There was found a quantity of turbid, bile-stained fluid in the peritoneal cavity; the proximal duodenum and the pyloric end of the stomach formed an indurated mass adherent to the gall-bladder. It was not possible to definitely locate the pyloric ring. Intestinal contents were leaking from a hole in the upper surface of this mass at its junction with the gall-bladder. The gall-bladder was gently separated from the inflammatory mass and a perforation somewhat less in size than a twenty-five cent piece was revealed. The margins of this perforation were indurated for some distance. A finger introduced into the lumen located the pyloric ring as being situated on the stomach side of the opening, showing that the perforation was situated in the anterior wall of the first portion of the duodenum. It was impossible to tell from the appearance and feel of the mass whether it was simply inflammatory or not. Closure in the usual way was not feasible, so he reapplied the gall-bladder and sutured it carefully to the duodenum, easily and completely occluding the perforation. A posterior-gastro-enterostomy was then done. The patient's convalescence was uneventful and he was discharged from the hospital on the eighteenth day. This is the first time he had ever seen a perforation in the duodenum which could not be closed by suture.

DR. HERMANN FISCHER thought that it is not so very rare that one has difficulty in closing a perforation in the stomach or duodenum on account of acute inflammatory changes of their walls. Doctor Bolling's idea of using the gall-bladder as a cover for the perforation is undoubtedly of value. Another method of value under such conditions is to insert a catheter or a rubber tube which fits snugly into the hole. This is pushed through the pylorus into the duodenum. The tube and the wall of the stomach close to the perforation are surrounded and covered by a cuff of omentum which is fastened with the tube on to the parietal peritoneum. The patient can then also be fed through the tube the first days after the operation. The tube is removed on the fifth or sixth day. Usually there is no leakage and the small fistula heals in a few days.

## CARCINOMA OF SPLENIC FLEXURE OF COLON—PRIMARY RESECTION

DR. HERMANN FISCHER presented a woman who entered the hospital in September, 1926, complaining of pain in abdomen and constipation. Her menstrual history was that for some time back she had been flowing more profusely, had suffered from backache and general discomfort in abdomen. The pain in her abdomen came in attacks sometimes very severe and often nauseated her. The pain was of colicky character and occurred mostly on the right side in the region of the cæcum. Her appetite was fair but she was run down and nervous.

*Examination.*—Shows abdomen somewhat generally distended, more so on the right side than on the left. No visible peristalsis. Directly above the symphysis the abdomen is quite tender on pressure. There is an indistinct irregular mass in the lower abdomen which, however, cannot be mapped out very clearly on account of the distention and general sensitiveness of the abdomen.

Bi-manual vaginal examination reveals a large myoma of the uterus with an inflammatory mass of the left ovary and tube. - No blood or mucus in stool at any time.

September 20, 1926, a supra-vaginal hysterectomy was done.

It was found that beside the myoma of the uterus there was a large hemorrhagic cyst of the ovary and a chronic salpingitis. This mass was tightly adherent to the lower sigmoid flexure, pulling it down deeply into the pelvis. The gut above was somewhat distended and it was thought at the operation that this tumor of the adnexa had caused the obstructive symptoms.

She made an uneventful recovery from this operation and was ready to be discharged when she was again seized with acute abdominal pain with vomiting and distention and inability to pass fæces. This, however, was easily overcome by high oil enema. She left the hospital the next day and went to the country to recuperate.

There, however, her attacks of constipation recurred. She was treated by a local physician with high enemata but she was only partially relieved and therefore reëntered the hospital in November.

On reëxamination there was found a uniform distention of the whole abdomen and a careful X-ray examination showed that the point of obstruction was in the transverse colon near the splenic flexure.

She was re-operated upon November 17, 1926, and a scirrhus carcinoma was found. This was removed by resection and by mobilizing the descending colon a lateral anastomosis between colon transversum and descending colon was done. From this operation she made a good recovery; up to the present time she has gained 20 pounds in weight and is feeling perfectly well.

DR. MORRIS K. SMITH recalled a similar case operated upon by him several years ago. The patient was a middle-aged woman with large bilateral ovarian cysts. The abdomen was distended. Her constipation and gas symptoms were attributed to pressure caused by the cysts. At operation after removal of the cysts Doctor Smith on putting his hand in the pelvis encountered a further mass. He lifted it up and it was revealed as an annular carcinoma of the sigmoid. He did a resection and there was a satisfactory recovery, which proved to be only temporary, for the patient had recurrence one year later.

DR. JOHN DOUGLAS said that it is not unusual to find a secondary pathological lesion that causes symptoms after the primary condition, which was thought to be the cause of the illness has been removed. The speaker saw a case not long ago sent in to the hospital with a diagnosis of appendicitis. The patient also had a uterine fibroid. The surgeon made a midline incision and first examined the appendix and then took out the fibroid. He looked again at the appendix and found an annular carcinoma, situated at the ileo-cæcal valve. He did a resection and the woman made a good recovery. Another case, operated on for uterine prolapse, had hemorrhage from the bowels while recovering. Three months later she got up an acute obstruction and carcinoma of the descending colon was found. This had evidently been

## MEGACOLON

present at the former operation. In another case a man operated on for umbilical hernia got up an acute gall-bladder inflammation while recovering from the operation for the hernia. It is not uncommon for a secondary lesion to be present and it is doubtful how missing this can be avoided unless one makes a complete intra-abdominal search which is not always practicable.

### MEGACOLON—INDICATIONS FOR SURGICAL TREATMENT

DR. RICHARD W. BOLLING read a paper with the above title, for which see page 62.

DR. LEON T. LEWALD (by invitation) said that he made his first X-ray examination of a case of megacolon about 1912, and had seen about ten of these cases since then, several of them being some of the cases shown by Doctor Bolling; others were seen at the University and Bellevue Medical College Clinics. One interesting observation was the apparent obliteration of the liver shadow. Doctor LeWald had called attention to this in his book, "Digestive Disturbances in Infants and Children," in which he said, "In this connection a very interesting observation may be made, namely, that the gas contained in the dilated bowel permits such an easy penetration of the body that the liver shadow may not be visible. One is likely to misinterpret the Röntgen appearance and believe that the liver has been displaced by the colon. Careful study in various positions, especially exposures made with the patient in the dorsal position and the ray passing from before backward, will reveal the liver in the normal position with the colon superimposed upon it." A case of Dr. J. Alexander Miller's was shown to the speaker a few days ago in which the *apparent* absence of the liver shadow had been noted. It is a peculiar phenomenon and is illustrated in one of the slides shown by Doctor Bolling. If a *lateral* view is taken the liver shadow will be seen *behind* the dilated colon. The exact explanation is not easy. One explanation is the displacement of the denser structures by the distended colon, and hence the X-ray has less tissue to penetrate, consequently causing more exposure over that region of the X-ray film, and producing a density which obliterates the usual shadow. It looks, however, as if the X-ray, in passing through the gas-filled colon, is in some way influenced so that it penetrates the denser structures, such as the liver, more readily, and thus produces over-exposure of that portion of the film and obliterates the usual shadow of the liver. The speaker agreed with Doctor Bolling as to the way in which some of these cases go on for years with little in the way of symptoms. If one ever expected to see a case of so-called toxic absorption, one would look for it in these cases. And yet in all of the cases he had seen the speaker had found little evidence of toxic absorption. It may be that they become immune to the absorption of toxic material from retained fecal matter and by-products of intestinal stasis.

DR. JOHN C. A. GERSTER reported the case of a boy of eleven with megacolon, operated on by Dr. A. A. Berg, in which only three or four inches of rectum were left. Within three weeks the child was skin and bone from dehydration. There were repeated diarrhoeal movements at this time. Doctor Schick, the pædiatrician, suggested subcutaneous injections of olive oil (about 100 c.c. per day) and slow but distinct improvement began and continued. The treatment was kept up for six weeks and recovery ensued. Some of the olive oil encapsulated but this was of no moment.

## BOOK REVIEWS

GYNÆCOLOGICAL DIAGNOSIS AND PATHOLOGY. By A. H. F. BARBOUR, M.D., LL.D., Formerly Lecturer on Gynæcology in the University of Edinburgh, and B. P. WATSON, M.D., F.R.C.S., Ed., Professor of Obstetrics and Gynæcology in Columbia University. Third Edition Reprinted. New York, William Wood and Company, MDCCCXXVII. 'Octavo, cloth, pp. 223.

The text is beautifully planned, carefully and fully executed and supplemented by pertinent, profuse illustrations. There are two main divisions in the book. The first occupies thirty-four pages and deals with methods of diagnosis. The second occupies the remainder of the book and considers the pathological conditions. This is not in any sense a text-book but is more a guide to the method of study of gynæcology. The authors have taken the specimens that have been examined by themselves over a period covering several years. Naturally these include the more frequent gynæcological problems confronting the surgeon. In the text the pathology relative to the clinical conditions is carefully described. Accompanying the descriptions there appear illustrations of the gross condition. These are followed by microphotographs which depict the cellular histo-pathology. In spite of its apparent brevity the subject matter is so condensed and so concisely presented that it covers almost every conceivable gynæcological condition.

In revision of the text for this last edition the changes have concerned themselves mainly in the portions dealing with the support of the uterus, the etiology of its displacements and with inflammations occurring within it. For the gynæcologist primarily and for the general surgeon as well as for the internist and diagnostician, this book cannot be too highly recommended.

MERRILL N. FOOTE.

THE TREATMENT OF FRACTURES. By CHARLES LOCKE SCUDDER, M.D. W. B. Saunders Co., Philadelphia, 1926.

The tenth edition of Scudder's, "The Treatment of Fractures," has appeared and is a remarkable compilation of the advances on the subject of fractures which have occurred since the publication of his last edition.

Doctor Scudder has drawn his material from many sources and has added special chapters on, Pathological Fractures by Bloodgood, on Bone Repair by Bancroft, on Fracture of the Mandible and Maxilla by Thoma, all of which are satisfactory additions to a work of this character.

Many of the chapters are encyclopædic in their handling of the lesion under discussion and Scudder has gone to great pains to give all the accepted forms of surgical therapy for the fracture under discussion. In many cases it would be more instructive did he give the method which he considered the most satisfactory, but for the student of the subject his is the comprehensive

method and gives the reader the choice of one of the several methods in use.

The chapter on fracture of the femur is an especially valuable one and worthy of close reading and his remarks upon the desired result, that is the result which should be obtained by the treatment, are worthy of italics. The separate consideration given to fractures of the femur in children is especially commendable.

Chapters 20 to 26 inclusive, which deal with the operative treatment, are very completely handled and especially well illustrated.

Chapter 28, which deals with massage and mobilization, is respectfully called to the attention of the surgeons, who expect to handle fractures, as the subject is beautifully condensed, and Scudder's remarks upon the inadequacy of this form of therapy and the lack of understanding of its usefulness and its dangers is worthy of careful reading.

As a whole, the book is a remarkable compilation of the knowledge and therapy of fractures and I believe marks an epoch in the American literature upon this complicated subject.

JAS. MORLEY HITZROT.

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## THOUGHTS ON THE FUTURE OF THORACIC SURGERY IN AMERICA\*

BY WILLY MEYER, M.D.  
OF NEW YORK, N. Y.

IN 1924, when attending the seventh annual meeting of the American Association for Thoracic Surgery at Rochester, Minn., I was asked at a dinner, given to the fellows and guests, to speak on "The Future of Thoracic Surgery." On that occasion I was absolutely unprepared. So I just said a few words as they happened to come to my mind at the moment. Since then I have given this question frequent and serious thought, and would now ask your indulgence for a few remarks on the subject.

Affections of the thoracic viscera—if we exclude for the moment empyema and tuberculosis of the lungs—are much rarer than those of the abdominal region, intra- and retro-peritoneal. The most frequent thoracic lesions encountered nowadays are those due to an acute traumatism resulting from automobile accidents, such as occur daily on our streets and country roads. The medical profession and the public still call them briefly "severe internal injuries." Other frequent causes are accidents in factories, shot or stabwounds and so forth. Up to this day many of these cases die without even an attempt being made to bring help, owing to the inability of the average medical man, on account of lack of proper training, to render a strict or preliminary diagnosis. Yet, what a large percentage of those thus afflicted could be saved, if even the mere principles of thoracic surgery and the necessary prompt surgical procedures, conservative and radical, were taught at college and were more generally practised.

The correct use of a trocar, and airtight connection of the rubber tube introduced into the chest through its canula with a syphon bottle under the operating table and later on under the bed of the patient, would in many such cases avert the immediate dangers of an increasing pressure pneumothorax, as it is so frequently observed in this class of accidents. If at a smaller hospital in the country the attending surgeon cannot be reached at once, this simple procedure at the hands of the house surgeon may bridge over anxious hours or even bring permanent help. After the arrival of the older doctor and further careful observation, an intercostal incision would promptly determine whether there is an internal hemorrhage above the dia-

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\* Read before the American Surgical Association, May 12, 1927.

phragm, and in that event the ligation of the bleeding vessels or the closing of a possible rent in the lung or bronchus would often save the patient's life.

If such work were done by the average surgeon, it would become an accepted fact that operating within the thorax is no more dangerous than operating in any other part of the body, the only additional care to be exercised being that of guarding against the danger of the onset of the acute pneumothorax.

The only variation, or, let us say, addition in the light of the most modern developments is, that it will be necessary for the anæsthetist to master the use of the Gwathmey apparatus—or any other kind of anæsthetizing apparatus embodying Tiegel's principle †—and of the tightly fitting mask, in order to administer the required anæsthetic, gas-oxygen, with or without ethylene, or any other mixture of an anæsthetic with oxygen, under sufficient pressure to avoid the otherwise threatening complete collapse of the lung, which, as is well known, adversely influences the work of the other lung by the flopping of the mediastinum. Tiegel, as early as 1908, demonstrated to the profession that one millimetre plus-pressure of oxygen suffices to rule out the accumulation of carbonic acid gas within the blood, which in the last analysis is the real cause of the patient's eventual death if an acute pneumothorax has not been properly guarded against.

To-day the negative chamber, positive pressure cabinets or boxes and intratracheal insufflation have become more or less obsolete. The pressure of the oxygen tank with the tightly fitting rebreathing bag is the only outfit required to make operative work within the thorax safe.

Do we then need men with special training for the practice of thoracic surgery alone? Certainly not, it seems to me. The men at the present time practically interested in thoracic surgery are all general surgeons who, on basis of their personal inclination and the great fascination of working within the chest, simply have added thoracic surgery to their usual daily work. Anæsthesia, asepsis, assistance, technic, all are the same as called for in operations upon other parts of the human body.

To my mind, therefore, thoracic surgery should constitute a part of the daily work of the general surgeon, at least in the small and medium-sized hospitals. Large institutions naturally require the division of the operative work, and here it may be advisable to entrust the thoracic part of the surgical work to one man, though rotation would probably be welcomed by many of the attending surgeons. It has been invariably observed that any surgeon who has once tested actual operative thoracic work will never give it up again, but will continue to practise it as a most fascinating addition to his routine work. The diaphragm should not and must not be the dividing line for the general surgeon! And inasmuch as thoracic surgery is not only the youngest child of general surgery, but also its last child, there now remaining not a nook or corner in our entire body that is still a closed book,

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† Tiegel, Max: Ein einfacher Apparat zur Überdrucknarkose. *Centralbl. f. Chirurgie*, 1908, vol. xxxv, p. 679.



the general surgeon's training should include also this branch of surgery. He should be able to reach every spot of the human organism with the knife. And this, let us add proudly, can now be done safely.

Quite naturally, in the first years or decades after a new chapter of medical science has been definitely opened, there is but a comparatively small number of men sufficiently interested to help evolve and develop the new chapter. These men do a sort of pioneering and specializing work. They are looked upon as being specially fitted to treat, and operate on, these cases, and rightly so; and they will have sent to them such cases by others. But later on, by sheer necessity, a larger proportion of the profession will become more and more interested; they will study the anatomy more carefully, will try to get the necessary training and then add the new branch of work to their daily routine. Gradually the chapter will lose the character of specialization and will become the *general property* of the profession. Particularly will the younger generation, I believe, be attracted to thoracic surgery. Thus, *e.g.*, at the Lenox Hill Hospital in New York—where the division of the operative work by regions of the body does not exist, because up to now the number of beds has not been large enough for such an arrangement—every attending, associate and adjunct surgeon is most enthusiastically interested in thoracic surgery.

This interest, I believe, will spread, and with the work in this particular field steadily increasing there will be established everywhere in this wide country, in all the medical schools of repute, clinics in thoracic surgery alongside of those already existing for other branches of surgery. In fact, I believe, that before long *all* surgical diseases of the human body will be discussed and treated in one and the same university clinic, with the exception, perhaps, of neurological and orthopædic surgery, and the specialties of eye, ear, nose and throat.

Still, it is only natural that many a surgeon will decide to practise thoracic surgery as a specialty, same as he may elect to be a specialist in the surgery of the brain, of the abdomen, the genito-urinary system, fractures, etc. However, the vast extent of our country requires the existence of men everywhere with an all-around surgical training, men that are prepared to give help in emergencies, no matter in what part of the body such help may be required; for, most of these acutely injured persons need prompt attention, they cannot and should not be obliged to travel over long distances to a large hospital, lest they die on the way.

For this and many other reasons, I think, it will soon be deemed necessary to add at least the teaching of the principles of thoracic surgery to the curriculum of the student in our medical colleges. At examinations to-day the student is required to know the anatomy and pathology of the chest. Before long, I am convinced, it will be considered wise to go a step further and teach him also how to bring help by operation, whenever such is indicated. I am sure the student will like the work, and many a young man will

decide to better round off his general surgical training by including thoracic surgery in his daily practice.

Of course, he will also add the required technic for empyema, acute and chronic, and the modern operations for pulmonary tuberculosis, which in their technic are no more specialized now than they were twenty-five years ago. He will be ready to operate, if needs be, on any of the various organs found in the chest, he will have learned from the experience of those who worked before him, and he will do his share toward the establishment of that all-essential coöperation with the internist, bacteriologist, radiologist and bronchoscopist, as is customary to-day in all those hospitals in which the attending staff can lay claim to the honor of being considered by the profession at large as "up-to-date men".

Summing up we might say:

1. Operative work within the chest is the same as in any other part of the body as far as surgical technic is concerned.

2. With the application of the customary asepsis, such work is also equally safe, if oxygen plus a volatile narcotic is added under pressure to the usual method of anæsthesia.

3. Injury of the thoracic viscera in accidents offers the most frequent indication for operation within the chest. Without prompt operation such injury often takes the patient's life in a few hours. If persons thus injured are conveyed to the nearest hospital they should there find the attending surgeons and their staff trained to bring help according to modern teachings and modern principles.

4. For these reasons it seems to be a matter of necessity that thoracic surgery, at least in its most important and vital principles, be added to the curriculum of the students in our medical colleges. Should such addition unduly crowd the already overburdened schedule of work, other less vital subjects should be dropped, the decision to be left to the judgment of committees appointed for this purpose.

5. The great fascination of this chapter of surgery will likely make such teaching a most welcome addition for the medical student as well as for the older surgeon.

6. Considering all these points, it is our belief that, in view of the favorable conditions under which thoracic surgery can now be undertaken, it will not be long before it will become as much the general property of the profession as is the surgery of the abdomen and of other parts of the body at the present time.

# THE RELATION OF IMMUNITY TO THE EXPERIMENTAL PRODUCTION OF ABSCESS OF THE LUNG\*

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AT THE meeting of this Association in Detroit one year ago we reported a method by which we could produce abscess of the lung in dogs with great constancy.† The method consisted of setting free in the jugular vein an embolus made by filling a small segment of the femoral vein with bacteria and blood. In an attempt to bring the experimental work into closer analogy with what occurs in human cases, unenclosed, infected clots were set free in the jugular vein. Such clots resulted in a wide variety of lesions but commonly in a rapidly spreading and fatal pneumonitis. It would appear that the type of lesion produced in the lung might vary either with the pathogenicity of the organism or the degree of immunity present in the animal at the time the embolus reached the lung. Last year with our presentation of the method by which abscess of the lung could be produced, we reported a single experimental study in which the immunity of the animal was varied by vaccination, previous operation, and the use of aseptic emboli.



FIG. 1.—Experiment I, Dog A: There is a localized area of increased density in the right lower lobe with a suggestive area of rarefaction in the centre (five days after embolism).

\* Read before the American Surgical Association, May 12, 1927.

† Cutler, E. C., and Schlueter, S. A.: The Experimental Production of Abscess of the Lung. *ANNALS OF SURGERY*, vol. lxxxiv, pp. 256-270, August, 1926; *Tr. Am. Surg. A.*, vol. xlv, pp. 149-171, 1926.

These early experiments concerning the part immunity may play in the production of embolic pulmonary disease led us to a more extensive investigation of this side of the problem. It is these studies which we now wish to present. They may be grouped as I, Studies in which the general immunity of the animal is concerned, and II, Studies in which the virulence and physical properties of the infected clot are concerned.

Our first studies dealt with the problem of general immunity in which the animals' immunity was varied by vaccination previous to operation. We thought that by increasing the resistance of the animal to the specific organism which was later to be used in the embolus, there would be present conditions comparable to what occurs in man where sepsis in the operative field may increase the immunity toward the organisms which might later reach the lung in a post-operative embolus. The following experimental arrangement throws some light on this question:

*Experiment I.*—Four dogs were used in this experiment. Varying degrees of immunity were conferred on Dogs A, B, and C by previous intravenous injection of a vaccine made from the same organism which was later used in the infected clots. This vaccine was made from a suspension containing virulent *B. coli* organisms (one twenty-four-hour agar slant culture in 6 c.c. of 0.4 per cent. phenol solution). The organisms were allowed to become attenuated during a period of forty-eight hours. Dog A was given 2 c.c. of this vaccine on three successive occasions with an interval of two days between the injections; Dog B was given 2 c.c. and two days thereafter 1 c.c. of vaccine; Dog C was given 1 c.c. of vaccine. Two days subsequent to the last injections, an infected clot (3 mm. by 10 mm.) was injected into the general circulation (*via* the external jugular vein) of each of these dogs as well as into a control (non-immunized) animal, Dog D. The resulting pulmonary lesions were followed with the aid of röntgenograms.

#### EXPERIMENT I

##### Protocol Dog A (Y 69).

Black and brown mongrel, male, wt. 11.9 kg.

Immunized as previously described (3 x 2 c.c. vaccine).

5-28-26—Temp. 38.5° C. Röntgenogram shows normal pulmonary fields. Under M. S. and local anæsthesia the left external jugular vein isolated and an infected clot (3 x 10 mm.) injected into the general circulation.

5-29-26—Temp. 39.4° C. Röntgenogram same as above.

5-30-26—Temp. 38.8° C. Röntgenogram same.

5-31-26—Temp. 39.0° C. Röntgenogram same.

6- 1-26—Temp. 40.5° C. Röntgenogram shows a localized area of increased density right lower lobe.

6- 2-26—Temp. 39.5° C. Röntgenogram shows the same area of increased density right lower lobe with area of rarefaction in the centre, Fig. 1.

6- 5-26—Temp. 38.6° C. Haziness in right lower lobe diminished.

6- 9-26—Temp. 37.3° C. Röntgenogram reveals some peribronchial thickening but the peripheral pulmonary fields are clear.

The dog apparently made a complete recovery.

##### Protocol Dog B (Y 70).

Brown and white mongrel, male, wt. 14.8 kg.

Immunized as previously described (2 c.c. and 1 c.c. vaccine.)

5-28-26—Temp. 37.0° C. Röntgenogram shows normal pulmonary fields. Under M. S. and local anæsthesia the left external jugular vein isolated and an infected clot injected into the general circulation.

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- 5-29-26—Temp. 39.9° C. Röntgenogram shows a triangular area of increased density (base toward the periphery) in region right lower lobe.
- 5-30-26—Temp. 38.7° C. Röntgenogram reveals a slight increase in the area of density noted above.
- 6-2-26—Temp. 38.0° C. Röntgenogram same as noted above except that there is a suggestive area of rarefaction in the centre, Fig. 2.
- 6-3-26—Temp. 38.0° C. Röntgenogram shows same localized area of increased density with some suggestion of resolution. Right lower lobe removed by lobectomy. The lobe is adherent to the lateral wall of the chest, friable adhesions being broken down without difficulty. The removed lobe shows upon its surface near the outer border a wedge-shaped portion of discoloration with the base toward the periphery. There is a small abscess in the centre of this surrounded by an area of increased density.

### Protocol Dog C (Y 71).

Short-haired white mongrel, female, wt. 6.9 kg.

Immunized as previously described (1 c.c. vaccine).

5-28-26—Temp. 38.2° C. Röntgenogram shows normal pulmonary fields. Under M. S. and local anæsthesia the left external jugular vein isolated and an infected clot injected into the general circulation.

5-29-26—Temp. 39.8° C. Röntgenogram same as above.

5-30-26—Temp. 39.9° C. Röntgenogram shows a well localized area of increased density in the left lower lobe with suggestive area of rarefaction in the centre.

6-1-26—Temp. 39.0° C. Röntgenogram reveals further increase in the area of localized density in the left lower lobe. The suggestive area of rarefaction in the centre is still visible.

6-2-26—Temp. 39.4° C. Röntgenogram shows some slight increase in the area of increased density in the left lower lobe, the central area of rarefaction appearing larger.

6-3-26—Temp. 39.2° C. Röntgenogram suggests some resolution of the area of increased density, and it was decided to sacrifice the dog. Necropsy reveals a fairly well consolidated left lower lobe, the adjoining portion of the left upper lobe being adherent to the lower lobe with some slight infiltration. The visceral pleura overlying the left lower lobe is thickened and there appears to be some breaking down of the pulmonary tissue near the tip of the lobe. Upon sectioning the lung through this area a fairly large abscess is found near the tip of the lobe, the surrounding lung being the site of a suppurative pneumonitis, Fig. 3.

### Protocol Dog D (Y 72).

Brown and white short-haired mongrel, wt. 6.9 kg.

Control animal (not immunized).

5-28-26—Temp. 38.2° C. Röntgenogram shows normal pulmonary fields. Under M. S. and local anæsthesia, the left external jugular vein isolated and an infected clot injected into the general circulation.

5-29-26—Temp. 39.7° C. Röntgenogram shows diffuse cloudiness of right lower lobe.

5-30-26—Temp. 40.3° C. Röntgenogram reveals marked increase in density right lower lobe and some increase in density in region of left lower lobe, Fig. 4.

Exitus. At necropsy cloudy hemorrhagic fluid found in both pleural cavities. Fluid cultured and pure strain *B. coli* obtained. Right lower lobe quite densely consolidated and left lower lobe shows scattered areas of infiltration (apparently the site of diffuse suppurative pneumonitis).

Dog A, which presumably had acquired the greatest degree of immunity, developed a small localized abscess which rapidly resolved; Dog B possessed a lesser degree of immunity, sufficient, however, to localize the lesion; Dog C had very little immunity toward the organism, and although the lesion was quite diffuse at first, it was subsequently walled off; Dog D (control, non-immunized) failed to localize the process and developed a diffuse pneumonitis which ultimately resulted in death.

In a series of four such experiments it was found that the animals in which some degree of immunity had been established by vaccination tended to wall off the reaction about the unenclosed, infected clot and to produce abscess of the lung. The control animals in such experiments usually succumbed to a diffuse pneumonitis.



FIG. 2.—Experiment I, Dog B: There is a small area of rarefaction in the central portion of a triangular area of increased density in the right lower lobe (five days after embolism).

The foregoing experimental series, however, was not similar to what might be present in human cases in that the clot was manufactured *in vitro*. To obviate this objection a series was started designed to produce an infected intravascular clot in the living animal. To create the necessary conditions, a vein was exposed, traumatized and the tissues about it were then

infected. These factors were met by the following experimental plan.

*Experiment II.*—The left external jugular vein was isolated and a proximal ligature placed in order to create stasis and to avoid possible premature separation of the thrombus. The wall of the vein was traumatized distal to the ligature for a distance of 2 cm. by repeated pinching of the wall of the vein with a haemostat. The cul-de-sac distal to the ligature was allowed to fill with blood and a clamp was placed at the upper limit of the traumatized area of vein to isolate temporarily the segment of vein with its contained blood from the general circulation. Three minims of a saline suspension of *B. coli* (3 c.c. saline to a twenty-four-hour agar slant culture) were then introduced into the isolated segment by means of a syringe and needle and thoroughly mixed with the blood. Three minims of this mixture of blood and bacteria were then withdrawn and allowed to contaminate the surrounding tissues. The clamp was then removed and the wound closed. In the majority of cases this procedure resulted in thrombosis within twenty-four hours which could subsequently be used as a source for infected emboli. After twenty-four hours the segment of thrombosed vein was excised between clamps, the thrombus shelled out and a measured fragment injected into the general circulation

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*via* the opposite external jugular vein by means of a syringe, cannula and 30 to 40 c.c. of saline.

The lesions obtained with this procedure were almost identical with those obtained when the unenclosed, infected clot was employed, providing the thrombus was excised and injected within twenty-four to thirty-six hours after its formation. If it was allowed to remain three, four, or five days before excision and injection, a lesion rarely resulted. This naturally suggested that with the elapse of time certain changes occur which either modify the general resistance of the animal or the character of the thrombus (consistency and virulency). In view of the fact that the experiment extends over a relatively brief period of time, the character of the thrombus is probably a more dominant factor than the question of the acquired immunity.

The further factor of the variation in the character of the thrombus from which the embolus arises called forth additional experiments. In an effort to investigate the possible relation between the character of

the embolus and the type of the pulmonary complication resulting therefrom, we conducted a series of experiments employing three animals in each, in which the variations in the character of the embolus were achieved by utilizing in Dog A, a segment of a twenty-four-hour thrombus excised from another animal (homologous), in Dog B, a segment of a twenty-four-hour thrombus excised from the same animal (autogenous), and in Dog C, a segment of a seventy-two-hour thrombus excised from the same animal (autogenous). The thrombosis in each case was produced in the manner previously described, the same suspension of organisms employed and the animals standardized in so far as possible. The conditions established in A were a thrombus exposed to the tissues of the body for twenty-four hours, animal not subjected to the infection; in B a thrombus exposed to the tissues of the body for twenty-four hours, animal subjected to the infection; in C a thrombus exposed to the tissues of the body for seventy-two hours, animal subjected to the infection.



FIG. 3.—Experiment I, Dog C: There is an area of increased density in the left lower lobe with an area of rarefaction in the centre (six days after embolism).

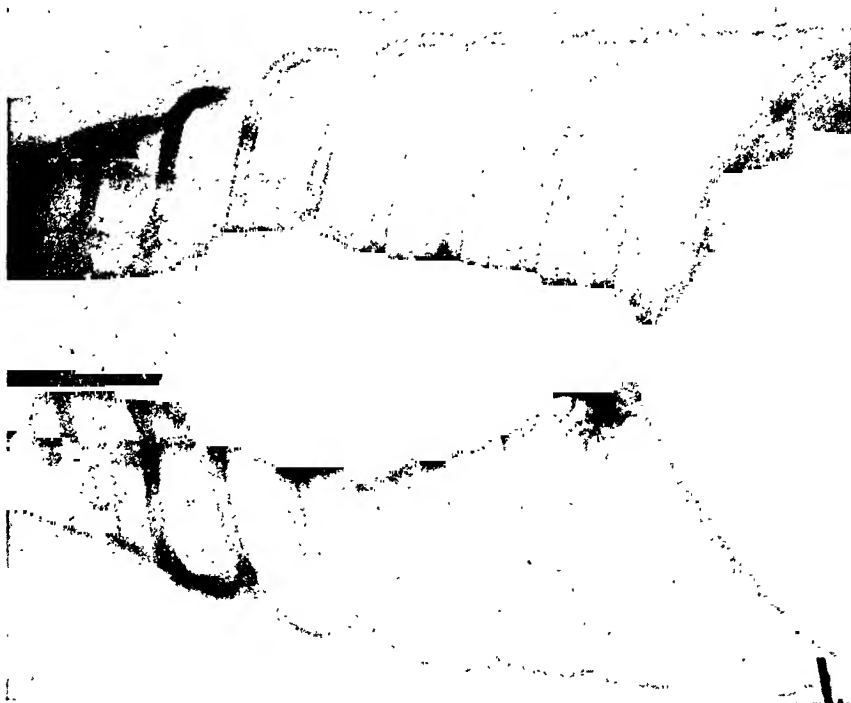


FIG. 5.—Experiment II, Dog A: There is a sharply circumscribed area of increased density in the left lower lobe (one day after embolism).

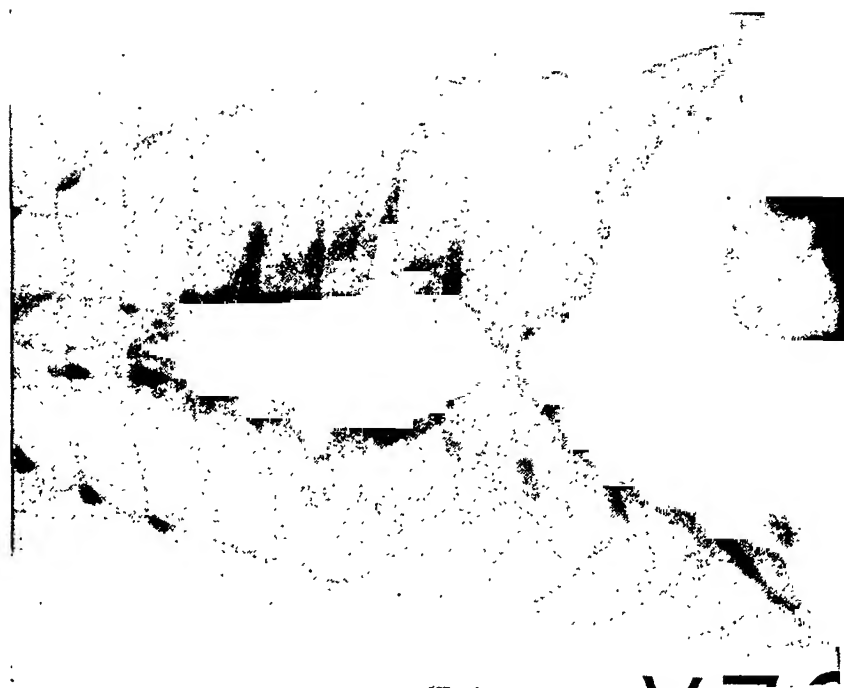


FIG. 4.—Experiment I, Dog D: There is an increase in density in the entire right lower lobe and the upper portion of the left lower lobe (two days after embolism).



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## EXPERIMENT II

### Protocol Dog A (W 34).

Brown and white collie, male, wt. 14 kg.

3-20-27—Temp. 38.8° C. Röntgenogram reveals normal pulmonary fields. Under M. S. and general anæsthesia a segment (3 x 8 mm.) of twenty-four-hour thrombus (homologous) injected into the general circulation *via* the right external jugular vein.

3-21-27—Temp. 40.0° C. Röntgenogram shows a sharply circumscribed area of increased density in the left lower lobe, Fig. 5.

3-22-27—Exitus. Necropsy reveals a bilateral sero-purulent effusion (*B. coli* cultured), increased density of entire left lower lobe with an even firmer area (2 x 2 cm.) in the centre.

### Protocol Dog B (W 35).

Brown collie, male, wt. 16 kg.

3-19-27—Temp. 38.6° C. Röntgenogram reveals normal pulmonary fields. Under M. S. and local anæsthesia the left external jugular vein isolated and thrombosis initiated in the usual manner.

3-20-27—Temp. 39.4° C. Röntgenogram same as above. Under M. S. and general anæsthesia the thrombus excised in the usual manner and a segment (3 x 8 mm.) of thrombus (autogenous) injected into the general circulation *via* the right external jugular vein.

3-21-27—Temp. 40.6° C. Röntgenogram shows a diffuse area of increased density right lower lobe and upper portion left lower lobe, Fig. 6.

Exitus. Necropsy reveals a bilateral sero-purulent effusion (*B. coli* cultured), a right lower lobe of increased density throughout, an increase in density upper portion of left lower lobe and small areas of infiltration throughout the other lobes.

### Protocol Dog C (W 36).

Brown, black and white collie, male, wt. 16 kg.

3-19-27—Temp. 38.6° C. Röntgenogram shows normal pulmonary fields. Under M. S. and local anæsthesia the left external jugular vein isolated and thrombosis initiated in the routine manner.

3-21-27—Temp. 39.0° C. Röntgenogram same as above.

3-22-27—Temp. 39.2° C. Under M. S. and general anæsthesia the thrombus excised in the usual manner and a segment (3 x 8 mm.) of the thrombus (autogenous) injected into the general circulation *via* the right external jugular vein.

3-23-27—Temp. 39.0° C. Röntgenogram same as above.

3-26-27—Temp. 39.2° C. Röntgenogram same, Fig. 7.

3-28-27—Temp. 38.8° C. Röntgenogram same. Sacrificed. Necropsy, all lobes air-containing throughout, a lesion not present.

Thus far (five series), all of the C dogs have escaped any serious pulmonary lesions as revealed by röntgenograms for several days following injection and by necropsy; those surviving were sacrificed on the sixth day. As for the A and B dogs, all have developed either a diffuse pneumonitis and a sero-purulent effusion with subsequent exitus in twenty-four to forty-eight hours or a well-localized lesion (single or multilocular abscesses) which necessitated sacrifice upon the sixth day for necropsy. Inasmuch as the above types of lesions were about equally distributed in the A and B dogs, we cannot make any distinction between them; however, it is our definite impression that the B dogs have had the more severe reaction. Needless to say, further data is necessary. Nevertheless, this brings up the interesting question of a reduced or "negative phase" in the general resistance at the onset of an infection.



FIG. 7.—Experiment II, Dog C: There are no definite areas of increased density (four days after embolism).

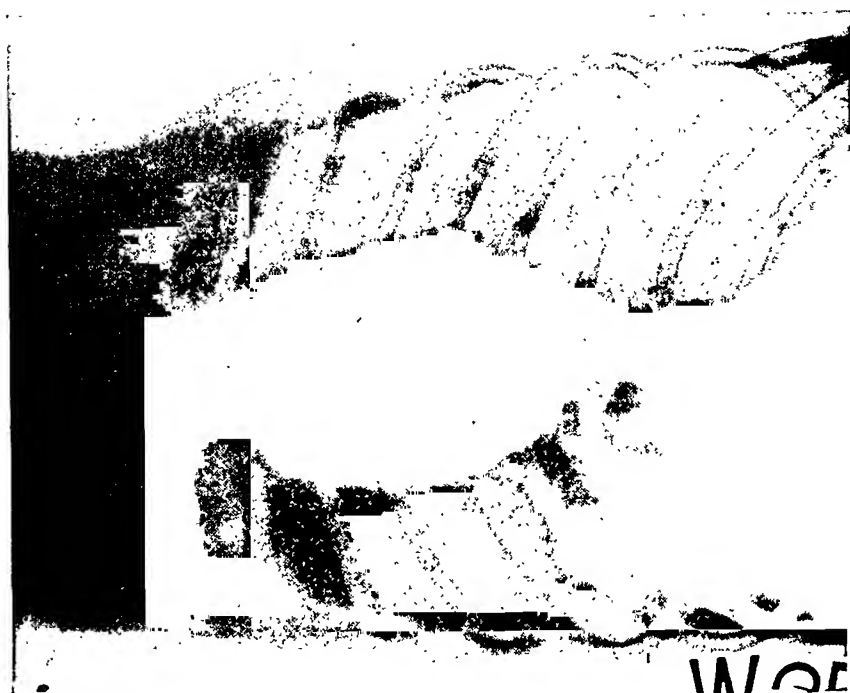


FIG. 6.—Experiment II, Dog B: There is increased density in the region of the entire right lower lobe and upper portion of the left lower lobe (one day after embolism).

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The uniformity in the results obtained in the C dogs suggests that the older the thrombus from which the embolus arises, and therefore presumably the more attenuated the organisms within it, the greater the liability to a minor and less disturbing pulmonary complication. Somewhere between the two lies the question of the production of abscess of the lung. It is obvious that to produce abscess we must have on one hand organisms present of such virulence as to continue growth, and on the other the further and more intricate problem of an immunity insufficient to kill off the organisms when they reach the lung and yet sufficient to wall them off into a localized lesion.

In reviewing the question of those suppurative pulmonary complications which are embolic in origin, it would seem that there are three variables, any one of which might become a dominant factor in determining the type of lesion resulting. We elected to maintain the organism unaltered and in Experiment I, attempted to vary the resistance of the animals; in Experiment II, we sought to vary the character of the embolus. Under the conditions of our experiments, the results obtained in Experiment I, would suggest a localizing influence upon the part of a high general resistance; those obtained in Experiment II, would suggest that the older the thrombosis from which an embolus arises, the greater the likelihood that a minor and less serious pulmonary complication will result.

# THE TREATMENT OF PULMONARY SUPPURATION<sup>1</sup>

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PULMONARY suppuration reveals itself in many forms. Obviously, therefore, no particular treatment can be applicable to all cases. Roughly speaking, we may think of acute and chronic cases, but in each group one recognizes many widely different types. For example, among the acute cases there occur such variations in pathology as a single well-defined abscess, multiple unilateral or bilateral small abscesses, a diffuse suppurative pneumonitis, etc. Again, any one of these may be associated with complications, such as a foreign body, empyema, meningitis or brain abscess, pericarditis, suppurating nasal sinuses, etc. When a pulmonary suppurative process becomes chronic it may assume the form of a chronic single large abscess, of multiple abscesses, or of bronchiectasis which is usually also associated with multiple small abscesses. It may also be accompanied by any or all of the complications mentioned above and in addition it very often is associated with a carcinoma of the lung, either primary or metastatic, or with pulmonary tuberculosis. Moreover, since pulmonary suppuration is a non-specific disease, it may be due to a great variety of microorganisms. The clinical course, prognosis and treatment will to some extent be affected by the variations in the infecting agents.

The methods of healing, however, of a suppurative process are fundamentally the same, regardless of whether it is in the lung or in any other organ of the body. Likewise, the principles of treatment of a pulmonary suppuration are essentially the same as those of any other suppuration. These are removal of foreign bodies, establishment of drainage, obliteration of cavities, general supportive measures and, when necessary, the removal of the diseased tissue. Certain anatomical peculiarities, however, in addition to a knowledge gained by experience, make it necessary to consider in a somewhat detailed manner how these fundamental principles can best be carried out. But it is also obvious that in the short time allotted for a paper of this kind only certain details can be considered.

A considerable number of cases of pulmonary abscess will heal spontaneously if allowed an opportunity to do so without the interference of a surgeon. Just how frequently spontaneous healing occurs it is impossible to say, because doubtless many of those which heal themselves without interference are not diagnosed. But from our own experience I am certain that many pulmonary abscesses are healed spontaneously without any treatment whatever, probably 25 per cent. or more. These are usually the cases in

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<sup>1</sup> Read before the American Surgical Association, May 12, 1927.

## THE TREATMENT OF PULMONARY SUPPURATION

which adequate drainage is accomplished by the rupture of the abscess into a large bronchus. They are therefore usually the cases in which the abscess is situated near the root of the lung instead of at its periphery. Complete rest in bed is of the greatest importance in the treatment of an acute pulmonary abscess. This matter has been stressed by Pritchard and by Miller and Lambert, and we agree heartily with them.

It seems perhaps unnecessary to state that the treatment of a case of pulmonary suppuration should begin with a diagnosis. This diagnosis should include not only the obvious feature of the location of the lesion, but also such additional features as the presence of tubercle bacilli in the sputum, of large numbers of spirochetes in the washed pus coughed up, the presence of a foreign body either aspirated or spontaneously formed as a broncholith, the possibility of concurrent malignant disease of the lung, the association of complications, such as meningitis, brain abscess, empyema, pericarditis, etc. It is beyond the scope of this short paper to discuss the ways and means of diagnosing these various aspects of a case, but a mere enumeration of them illustrates the advisability of special training and experience in the handling of these cases.

There seems in many cases, particularly the chronic ones, to be an important relationship between suppuration in the nasal sinuses and suppuration in the lung. It is often astonishing to see the marked improvement



FIG. 1.—Diagram of operation of cautery pneumonectomy to show how massive drainage and gradual extirpation of the diseased portion of lung can be accomplished. Pressure can also be accomplished in any desired degree by the amount of packing in the wound.

which occurs in a case of chronic pulmonary suppuration after the correction of suppuration in the nasal sinuses. Many of those cases associated with spirochetal infections become healed in a very dramatic manner merely by the administration of an intensive course of treatment with neosalvarsan. It is becoming more and more evident that such cases are much more frequent than was formerly supposed. In the experience of Singer and myself during the last year as many as 74 per cent. of our cases were found by Doctor Varney of the department of bacteriology to be associated with large numbers of fusiform bacilli or spirochetes in the sputum. Not all of them, however, will respond to treatment with neosalvarsan. Many of the cases initiated by the aspiration of a foreign body will recover promptly after the removal of the foreign body, but again not all.

There are various ways by which drainage may be improved. The simplest is by posture. Another is by the bronchoscope. It may be stated in passing, however, that too much reliance should not be placed upon this instrument as a therapeutic agent except for the removal of foreign bodies. The bronchoscopists must yet demonstrate its effectiveness in the treatment of pulmonary suppuration. It is astonishing that despite the claims often made for the therapeutic value of this instrument there have been published practically no statistics giving results of treatment. The only series which I have been able to find is that published by Moore<sup>2</sup> of Jackson's Bronchoscopic Clinic. In spite of the large number of cases treated at that clinic by the acknowledged masters in this field, the results in only thirteen cases are given. Of this number, 25 per cent. are reported as cured, 42 per cent. as improved, and 33 per cent. as unimproved. These results seem still less impressive when it is recalled that the very type of case in which the bronchoscope is most effective is the type situated at the root of the lung, the type in which the largest percentage of spontaneous recoveries occurs. Finally drainage may be increased by surgical interference. From an experience based on 329 cases of pulmonary suppuration, exclusive of empyema and tuberculosis, Singer and I feel that the indications for surgical drainage are impelling only in those cases in which the abscess is situated near the periphery of the lung, in those cases in which spontaneous drainage through the trachea has become shut off with a resultant extension of the inflammatory process, and finally in certain of the chronic refractory cases. The mortality will be less if surgical drainage is not undertaken too early. It is extremely dangerous to go through a large oedematous portion of lung in order to reach the abscess. If the abscess has ruptured into the pleural space, often drainage of the empyema will be the only surgical interference necessary.

Compression of the diseased tissue is a very effective means of obliterating cavities and it also may make the drainage more efficient especially if the abscess is near the hilum. The simplest method of inducing compression is by artificial pneumothorax. The best results with pneumothorax are obtained

<sup>2</sup> Moore, W. F.: *Bronchoscopic Treatment of Suppurative Diseases of the Lungs.* Jour. A. M. A., 1924, vol. lxxxii, p. 1036.

in subacute abscesses which are not located at the periphery of the lung. In the peripheral cases there is danger of rupturing the abscess into the pleural cavity. Artificial pneumothorax, to be effective, must be continued for at least several weeks and sometimes for several months. Other methods of producing compression, as for example by an extrapleural thoracoplasty or by paralyzing the diaphragm on the affected side by avulsion of the phrenic nerve, should be reserved for the relatively chronic cases. More will be said about them below.

Many of the cases which are seen are chronic with histories of their trouble extending back for years. Probably in all cases of chronic pulmonary suppuration chronic abscess and bronchiectasis go hand in hand. In some cases, however, the features of bronchiectasis predominate and in others those of chronic abscess. In any case it seems to me inadvisable to consider radical surgery at once. Many of these cases, even of a duration of years, make surprising recoveries after comparatively simple treatment by such means as pneumothorax, neosalvarsan, the correction of suppurating nasal sinuses, rest in bed, heliotherapy, etc. But in the refractory cases the question always arises as to what type of surgical interference should be performed. As in a chronic refractory infection in any other organ of the body, so here in the lung the most desirable surgical procedure would be the removal of the diseased tissue if it could be done safely. The ordinary operation of lobectomy, even in the hands of an expert like Lilienthal, seems to carry with it too high a mortality to make it a feasible procedure of great applicability. The reason for the excessive mortality (about 50 per cent.) is chiefly that the mediastinum and large raw surfaces on the diaphragm, chest wall, etc., produced by the mobilization of an adherent lobe, are exposed to an infection from the bronchial stump which is unavoidable in a large proportion of cases. To diminish this risk, an operation based on the principle of the two-stage Mikulicz resection of the colon is excellent when it can be carried out safely. To accomplish this the diseased portion of lung is brought outside the chest wall which is closed tightly around it. After adhesions have formed the outside portion is removed with a cautery. This procedure was proposed and carried out by Lockwood<sup>3</sup> in 1922. I have also found it an excellent and safe procedure in one case in which the mobilization and external delivery of the lung could be carried out easily. More recently Whittemore<sup>4</sup> has modified and enlarged the scope of the operation. There are cases, however, in which the mobilization of the lobe could not be safely carried out. These are the cases in which multiple abscesses predominate in the picture and in which there are excessive adhesions the tearing of which would allow the escape of pus.

Another method of removing the diseased tissue is by the operation

<sup>3</sup> Lockwood, A. L.: Abscess of the Lung. Surg., Gynec. and Obst., 1922, vol. xxxv, p. 461.

<sup>4</sup> Whittemore, W.: Treatment of Chronic Bronchiectasis. Boston M. and S. Jour., 1927, vol. cxcvi, p. 182.

which I<sup>5</sup> have described elsewhere which utilizes the actual cautery for this purpose. The operation of cautery pneumonectomy consists, first of an extensive exposure of the portion of lung affected, which is usually obtained by the removal of three or four ribs for a distance of about four inches each. Then, without separating adhesions but, on the contrary, establishing them if none already exist, a large area is cauterized with an actual cautery. At



FIG. 2.—Drawing made at operation immediately after a first cauterization. Note particularly the large exposure and the accessibility of the cavity to packing.

first no attempt is made to burn away a large mass of lung. The idea is rather to establish numerous bronchial fistulas through which massive drainage may be accomplished. At later stages, more and more lung can be burned away if necessary by increasing the depth of the cavity; but after providing for a few weeks such massive drainage as can be accomplished by the many bronchial fistulas, it frequently happens that much less lung tissue needs to be destroyed than was at first thought. These cases, after all, present only inflammatory lesions. The necessity of removing completely all diseased tissue is therefore not so great as if they were cases of malignant tumors. In my own experience in forty-five refractory cases of chronic suppuration treated by this method the control of hemorrhage has not been difficult. Large vessels that bleed during the cauterization are usually clamped and ligated. The wound is packed to avoid further bleeding. Bleeding even from the large vessels is easily controlled by packing because the blood-pressure in the pulmonary artery is usually only about 20 or 25 mm. of mercury. As a rule the packing is not disturbed for four or five days and an interval of at least two or three weeks is allowed to elapse between cauterizations. In more than 100 extensive cauterizations performed in the forty-five cases only once did a fatal hemorrhage occur. That was in a child whose hemorrhage occurred at night on the twelfth post-operative day. If the

<sup>5</sup> Graham, E. A.: Cautery Pneumectomy for Chronic Suppuration of the Lung: A Report of Twenty Cases. *Arch. Surg.*, 1925, vol. x, p. 392.



## THE TREATMENT OF PULMONARY SUPPURATION

patient had been an adult, the hemorrhage almost certainly would have been recognized early enough to allow its control with packing. Those who have had trouble with hemorrhage in this procedure have probably made the mistake of not having had a sufficiently large exposure, or of attempting to remove too much lung tissue at one cauterization.

The method, therefore, combines in one procedure all the known effective principles in the treatment of chronic pulmonary suppuration; namely, drainage, compression and extirpation of the diseased tissue. In fact, it accomplishes each of these principles perhaps more effectively than other procedures. The drainage is copious because of the cross-section of the bronchial tree and the creation of multiple bronchial fistulas. Likewise, compression of the affected portion of lung probably can be carried out more effectively and more precisely by this method than by pneumothorax or thoracoplasty, because the degree of pressure can be regulated simply by the amount of packing in the wound. Finally, as regards extirpation, since the lobe does not need to be mobilized there is no exposure of mediastinal pleura, pericardium, etc., to infection such as occurs in the case of the ordinary lobectomy. The chief factor in the operative mortality of lobectomy, suppurative mediastinitis, is therefore absent in this procedure. On the contrary, in the cautery pneumonectomy an effort is made always to stay inside the lung tissue.

Because of the almost complete absence of shock resulting from the operation it is particularly applicable to many cases which otherwise seem hopeless. For example, Singer and I have used it successfully in two cases of very severe bilateral suppuration. We have also used it with a strikingly successful result in the removal of a portion of lung that not only contained a chronic abscess, but was tuberculous as well, in a man, aged sixty-two, who although completely incapacitated and bedridden for two years before his operation, has now been at work steadily for almost two years, entirely free from symptoms.

This operation has been reserved for only the most refractory chronic cases, many of them representing very bad surgical risks. In all we have performed it in forty-five cases. Of this number there have been three deaths which were probably ascribable directly to the operation (a mortality of 6.6 per cent.). One of these was the case of hemorrhage already mentioned above, and the other two were deaths supposedly from air embolism. I cannot, therefore, regard the operation as a particularly dangerous one as judged by other operations for these conditions. One other case died of an acute cardiac dilatation on the sixteenth post-operative day and four other cases died later of suppurations elsewhere in the body. One case died two years later from air embolism after an attempt to close a bronchial fistula, another nearly three years later at home from an unknown cause, but probably from a recurrent infection of the lung, although the patient had been perfectly well for more than two years, and another one two years after the

operation supposedly from meningitis, indicating also, as in the preceding case, that some remaining infected tissue had caused trouble later. In all, eleven, or 24 per cent., of the forty-five cases are now dead from all causes during a period of three years since we began using the operation. Several of these cases were known to be desperate risks, but were operated on in the hope of improving their conditions. On the other hand, thirty-one, or 69 per cent., of the forty-five cases are free from symptoms. Three patients are still in the hospital greatly improved. Of the thirty-one patients free from symptoms, ten have bronchial fistulæ which, however, do not prevent them from carrying on their ordinary activities. It is possible that other procedures may prove to be more effective in certain kinds of cases; but it seems to me that certain cases, particularly the refractory cases of chronic multiple abscesses, can at present be handled more safely and more effectively by this type of operation than by any other yet suggested.

Hedblom<sup>6</sup> has reported marked improvement in a series of cases of the bronchiectatic type of chronic suppuration treated by the operation of extrapleural thoracoplasty; but in the cases which resembled more a chronic abscess his results were not nearly so good. My principal objection to this type of operation is that the diseased tissue is allowed to remain from which recurrences may still occur with the associated danger from hemorrhage, brain abscess, etc. It is not unusual to have symptoms recur a year or two after an apparent recovery if any diseased tissue has been allowed to remain. However, doubtless some cases will be permanently cured by this method; and the operation will probably remain as one of the recognized procedures for suitable cases. Phrenicotomy is often a helpful adjunct to any operation the purpose of which is to produce compression.

In any event the mortality in any large series of cases of chronic pulmonary suppuration will inevitably be high because in about 10 per cent. of the cases there will be an associated carcinoma of the lung, either primary or metastatic, and in about another 10 per cent. cerebral suppuration, either brain abscess or meningitis, will be present.

Various auxiliary measures are important, rest in bed, particularly, neosalvarsan in the spirochetal cases, properly directed heliotherapy, blood transfusions and a liver diet for the anemia (the latter following the suggestion of Murphy and Minot for pernicious anemia), and a high caloric diet.

#### CONCLUSIONS

Because of the variety of forms of pulmonary suppuration, no particular kind of treatment will be applicable to all cases.

Many cases will heal spontaneously and after comparatively simple methods of treatment, including rest in bed, postural drainage, etc.

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<sup>6</sup> Hedblom, C. A.: Graded Extrapleural Thoracoplasty in the Treatment of Diffuse Unilateral Bronchiectasis, 1924, vol. viii, p. 394.

The efficiency of the bronchoscope as a therapeutic agent, except in those cases associated with a foreign body, must yet be demonstrated.

Surgical drainage is applicable only to certain cases.

Various methods of compression are helpful in many cases.

In certain chronic refractory cases it seems desirable to remove some of the diseased tissue. For this purpose, safer improvements over the ordinary operation of lobectomy seem to be offered in the procedure of cautery pneumonectomy and in the modified lobectomy carried out by Whittemore. A series of forty-five cases in which the operation of cautery pneumonectomy has been carried out is discussed in which it is shown that in thirty-one cases, or 69 per cent., there is freedom from symptoms.

# MECHANICAL PRINCIPLES OF THE OPERATIVE TREATMENT OF PULMONARY TUBERCULOSIS \*

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THE mechanical principles of operations intended to influence favorably the course of tuberculosis of the lungs are factors in achieving two main objects: I. To produce immobility of the diseased parts, and II. To carry out of the body tuberculous exudates and discharges; in other words, to secure drainage.

But I and II invariably supplement each other and, inseparable from surgery, is physiology, especially the physiology of repair.

I shall discuss in this paper the mechanics alone, knowing that my hearers are already acquainted with the other influences which bear upon the disease and its pathological anatomy.

I. *Surgically Induced Rest.*—This may be of two varieties: A. Temporary rest—when the lung is not hopelessly diseased and may be expected to resume its function at the end of the treatment.

B. Permanent rest—with or without complete obliteration of the pulmonary air spaces both normal and

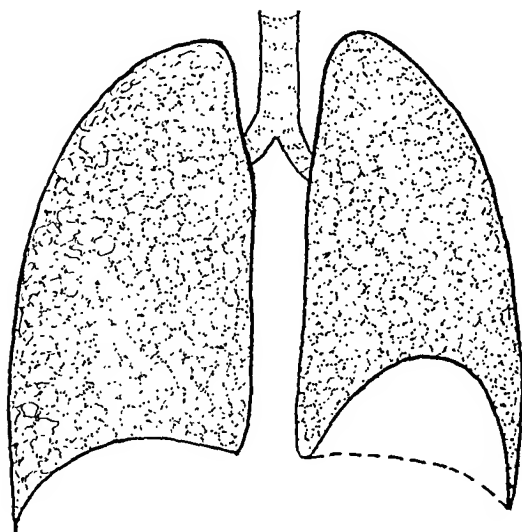


FIG. 1.—Diagrammatic drawing of coronal section of chest from front. The left diaphragm is elevated because of interruption of phrenic nerve impulses. Reduction of pleural capacity equivalent to from two to five hundred cubic centimetres of pneumothorax.

pathological. This principle is to be applied when disease has advanced to such a degree that attempted reestablishment of function will tend to produce an exacerbation of the tuberculosis.

A. Temporary Rest.—This may be accomplished by (1) an extrathoracic or (2) by intrapleural procedure, the effect of either being accompanied by a temporary reduction in pulmonary air volume.

(1) Extrathoracic procedure: The method referred to here is the ingenious device of Yates (*Archives of Surgery*, vol. xiv, No. 1, Part 2, pp. 369 to 380), who finds that by crushing the phrenic nerve with forceps the corresponding half of the diaphragm may be temporarily paralyzed so that it rises into the thorax, thus producing a partial collapse of the lung.

Judging by clinical results and röntgenographic appearances I conclude

\* Read before the American Surgical Association, May 12, 1927.

that the elevation of the diaphragm may effect a reduction in capacity the equivalent of from 200 to 500 c.c., more or less. This is not, however, the exact mechanical effect which pneumothorax of low tension produces for reasons which will be given farther on. Still both the capacity and the respiratory excursions of the lung are diminished by the procedure. (Fig. 1.)

This minor operation which Yates has designated by the name of *phrenemphraxis* is effective for a few months only, when gradually the function of the diaphragm is restored.†

During this period repeated transfusions and general hygiene are employed. In addition, the reduction in pulmonary capacity is accompanied by an increase in the proportion of blood delivered to the lung, a great advantage in the cure of tuberculous lesions.‡

(2) Intrapleural Procedure: The one most frequently employed is the production of artificial pneumothorax. In proportion to the degree and character of the lesion this

therapy is varied so that we have either full collapse and even compression of the lung with almost no respiratory function, or very slight collapse without actual compression. The latter, particularly in the early cases, often has an apparently selective effect placing at rest the diseased part of the lung while merely diminishing the function of the normal areas.

This selective action has been well described and explained by Bendove (Raphael A. Bendove, *Archives of Surgery*, vol. xiii, No. 3, p. 369), who, with a series of skiagrams, beautifully demonstrates the action of this form of pneumothorax.

Briefly, the explanation is based upon the fact that the infiltrated foci do not fill with air on respiration while the surrounding healthy lung expands and contracts. This, to be sure, probably happens to a less degree even without pneumothorax, but it cannot be demonstrated to the eye. Figures 2, 3, 4 and 5 are diagrams drawn from illustrations in Bendove's paper.

The selective action of low tension pneumothorax is the point previously

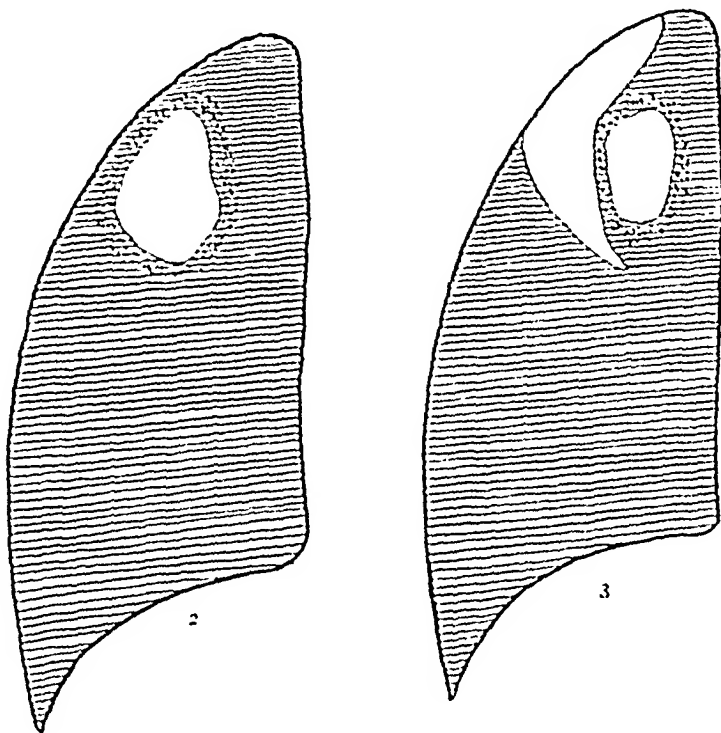


FIG. 2.—Infiltration and cavitation of right upper lobe.

FIG. 3.—Same case after introduction of 300 c.c. of air into the right pleura. Patient erect. Localization of the air in the upper chest.

† Permanent paralysis may, rarely, be produced by contusion of the nerve.

‡ Cloetta, quoted by Yates, *loc. cit.*

referred to in discussing the effects of phrenemphraxis. While the reduction in capacity may be the same, the pneumothorax has the advantage of the selective distribution just described. (Figs. 2, 3, 4 and 5.)

In cases of more extensive disease, it is usually advisable to produce more general collapse in an effort to set at rest the entire lung and this is done by increasing the volume of air within the pneumothorax until in complete cases the lung is not only collapsed, but may be compressed from all sides

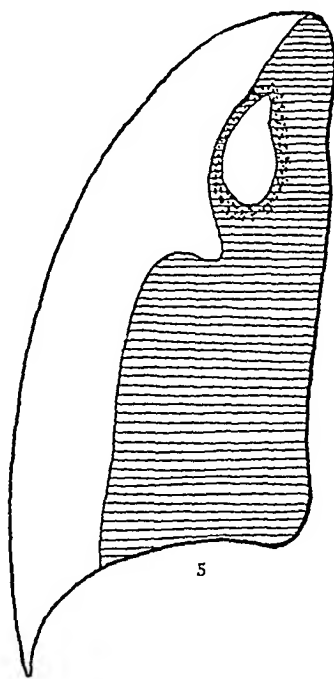
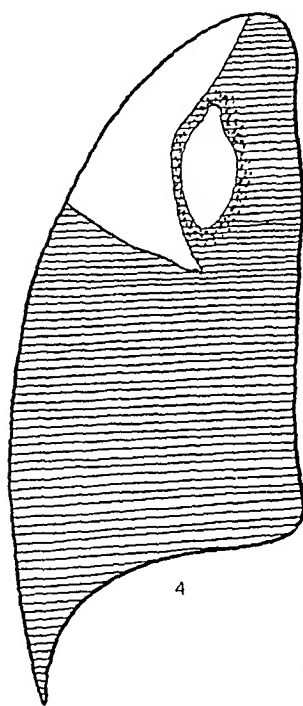


FIG. 4.—Same case in full inspiration nine days after initiation of pneumothorax; the diseased upper portion is compressed and the lower functioning portion expands and contracts with respiration.

FIG. 5.—Same case in expiration. Note motion of lower part of lung away from chest wall.

into a small atelectatic body or may be converted into a thin mass lying along the spinal gutter.

The air, however, is gradually absorbed, the lung slowly expands and if no more air is insufflated, there is a return to the normal filling of the chest and the usual negative pressure. It is, therefore, necessary to refill every few weeks in order to maintain the lung at comparative rest.

In spite of its undoubted benefits, pneumothorax possesses the disadvantages incident to frequent thoracic puncture with the well-known com-

plications of intrapleural effusion or tuberculous infection of the chest wall or both. Indeed, when mixed pleural infection appears, the complication may be a particularly dangerous one. On the contrary, in favorable cases, clinical cure is by no means rare. In any event full therapeutic pneumothorax is usually followed by great improvement in the general state of the patient and in the symptoms of his disease.

It has been suggested that a thin neutral oil might be employed instead of air or other gas as a compression medium in the pleural sac, the principal gain being that the necessity for refilling would be eliminated. This would be on the same mechanical principle as that present in the serous pleural effusions which so frequently occur in pulmonary phthisis. The method has never been given a thorough trial, although it has been experimentally used by Archibald and by Parfitt (Transactions of the National Tuberculosis Association for 1922, pp. 194 and 195). It has also been tested by me in non-tuberculous lung suppuration following intrathoracic operations. Here, in the presence of infection, it was useless and had to be withdrawn. The



at rest, even though the pneumothorax may bring temporary relief. It would seem that this class of cases would be the ones for which a non-absorbable medium might be most desirable.

A first step in producing permanent rest for an incurable lung is phrenic nerve avulsion, an operation preferable to mere section or resection because

accessory nerve fibres are thus eliminated which, if permitted to remain, vitiate the desired result of a paralytic diaphragmatic elevation.

I have elsewhere ¶ described this procedure and need not enter into its details here except to state that it is not ordinarily a dangerous one and that, if performed through a transverse incision upon the clavicle the resulting scar is almost invisible. Very great improvement may follow this operation including the cessation of hæmoptysis. (Fig. 8.)

Nature seems to make

an attempt to create rest in early tuberculosis when on fluoroscopy the diaphragm of the affected side reveals diminished motion or even rigidity in the presence of a small area of apical disease.

The commonest and most universally applicable method is that known as Sauerbruch's paravertebral thoracoplasty. The operation is well known to surgeons and need not be described here.

As a note in technic, I call favorable attention to a rib stripper, the invention of Dr. Ralph Matson, of Portland, Oregon. I have used it many times, always with the pleasure a workman finds in an excellent tool. The instrument is shown in Fig. 9.

The mechanical action of Sauerbruch's thoracoplasty deserves a little discussion.

Resection, or even the mere division of the ribs near the spine, is followed by a variable but often great reduction in the size of the thorax because

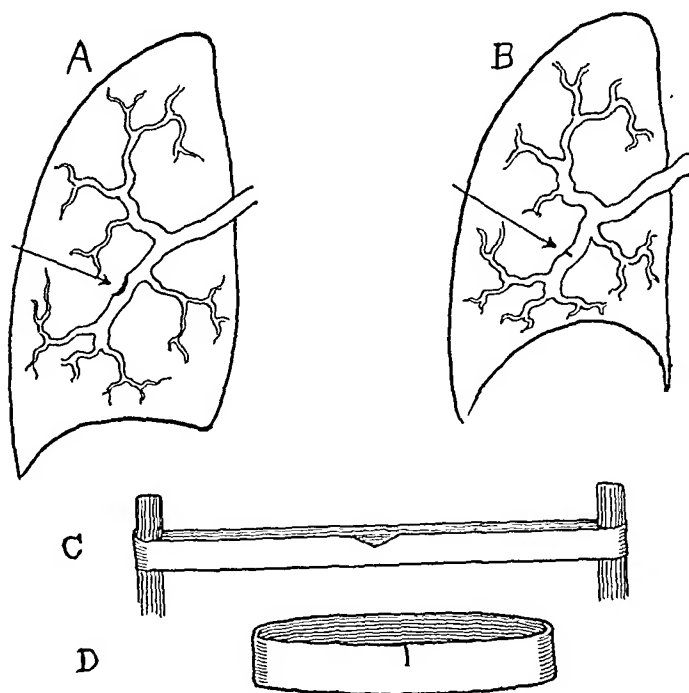


FIG. 8.—A. Lung under normal negative pressure. The blood-vessels are stretched. The arrow points to an ulceration in a vessel. B. Represents the same lung the tension relaxed by the elevation of the diaphragm. The wounded vessel shortens and the opening in its wall is closed. C. Represents a rubber band on the stretch with a nick in one edge. D. Same rubber band no longer under tension. The sides of the nick have fallen together.



FIG. 9.—Dr. Ralph Matson's rib stripper and raspatory.



## OPERATIVE TREATMENT OF PULMONARY TUBERCULOSIS

the ribs quickly assume a slant more nearly vertical than their normal obliquity. There is also a true depression of the ribs which is sometimes very marked, particularly of that part between the spine and the anterior axillary line. This is seen in its greatest degree in the upper ribs, especially the first, where a small resection, only about one-half inch, is frequently followed by a dropping of the now movable portion of this bone, so that its posterior extremity is at the level of the second interspace or even the third (Fig. 10), thus permitting nearly

the entire apex above the line of the clavicle to fall below this line. Muscular and tendinous attachments between the clavicle and the first rib hold the latter bone in its normal position and, in turn, the intercostal structures are in a great measure responsible for the support of the ribs below, especially the first four or five.

In order to gain the greatest effect in reducing the capacity of the upper thorax it is, therefore, essential that the first rib should be resected or at least divided, and this should be done

in the first stage of the thoracoplasty. Direct union of the cut ends of this rib rarely if ever occurs. It drops, as just stated, to the second or third space. In addition to the drop of the ribs following resection of their posterior portions, there is partial rotation which is permitted by the flexibility of the cartilages and, as the divided ribs become oblique, they approach each other in the axillary line and behind it even to the point of overlapping.

The full collapsing effect of this operation may not be manifest at first and its progress may continue for months or even a year. This is particularly the case in the lower chest where the longer costal sections have been removed and where union is often delayed. Patients in whom the lower chest-wall continues to move with respiration sometimes complain of painful or uncomfortable sensations as a result. This can be helped by wearing a firm support such as the strong elastic adhesive plaster known by the trade name of Elastikon (Johnson and Johnson).

In addition to the action of the trunk muscles, I am convinced that the



FIG. 10.—Dropping of the first rib to the third interspace following paravertebral thoracoplasty. The lower ribs have also dropped. Note their increased slant. Apex of lung above clavicle has disappeared.

steady negative pneumatic pull within the thorax is of much assistance in bringing about the desired contraction. This suggests one of the reasons for the difficulties encountered in obliterating a pneumothorax which is in direct connection with the outer air, whether through the chest-wall or through the bronchial tree; also the persistence of pulmonary cavities of large size which nearly always communicate with the outer air by way of the bronchi. I do not think that this point has been brought out before. It will



FIG. 11.—Late result of thoracoplasty illustrating fusion of ribs from top to bottom of chest producing great rigidity of thoracic cage. Note staggering position of ribs no end-to-end union. This operation was done for a non-tuberculous, general suppurative bronchiectasis of right chest. Clinical cure.

be referred to farther on.

The usual cases in which thoracoplasty is performed are those with cavities of not excessive size. Collapse here is generally prompt and efficient while in the presence of large apical cavitation the proportion of collapse in the lower two-thirds of the chest is much more pronounced than it is in the upper part, so that it is frequently necessary to perform additional operations such as apicotomy for direct compression. In tuberculous

empyema with full contraction of the lung and with drainage through an external fistula the chest wall must be actually caved in by a series of operations in order to obliterate the dead space.

Occasionally the opposite lung becomes the seat of compensatory emphysema deviating the mediastinum toward the collapsed lung or pleura, thus aiding in this obliteration.

Contrary to the operative indications in non-tuberculous empyema, in which everything is done to bring the lung to the chest wall, in tuberculous lung this is undesirable for an immediate increase in cough and expectoration will follow for reasons to be given later.

It is not the mere collapse or compression of the lung which produces the arrest of the tuberculous process so much as the limitation or abolition of respiratory movement. So that the degree of collapse in ordinary cases without pneumothorax or empyema need not be so great as that which is requisite when these complications are present. Indeed, in tuberculous pneumonia there may be very little collapse, the improvement being brought about almost entirely by immobilization.

## OPERATIVE TREATMENT OF PULMONARY TUBERCULOSIS

Let us assume that there is a pneumothorax, closed or open. Ordinarily there is respiratory motion in these circumstances, expansion of the lung occurring with expiration instead of with inspiration. Still, the mere presence of motion, however little, is a disadvantage. I have seen cases of closed empyema with pulmonary compression in which there was little or no expectoration and but little cough, but in which cough and profuse expectoration occurred the moment that external drainage by thoracotomy was established. This increase in expectoration will, however, greatly diminish as the

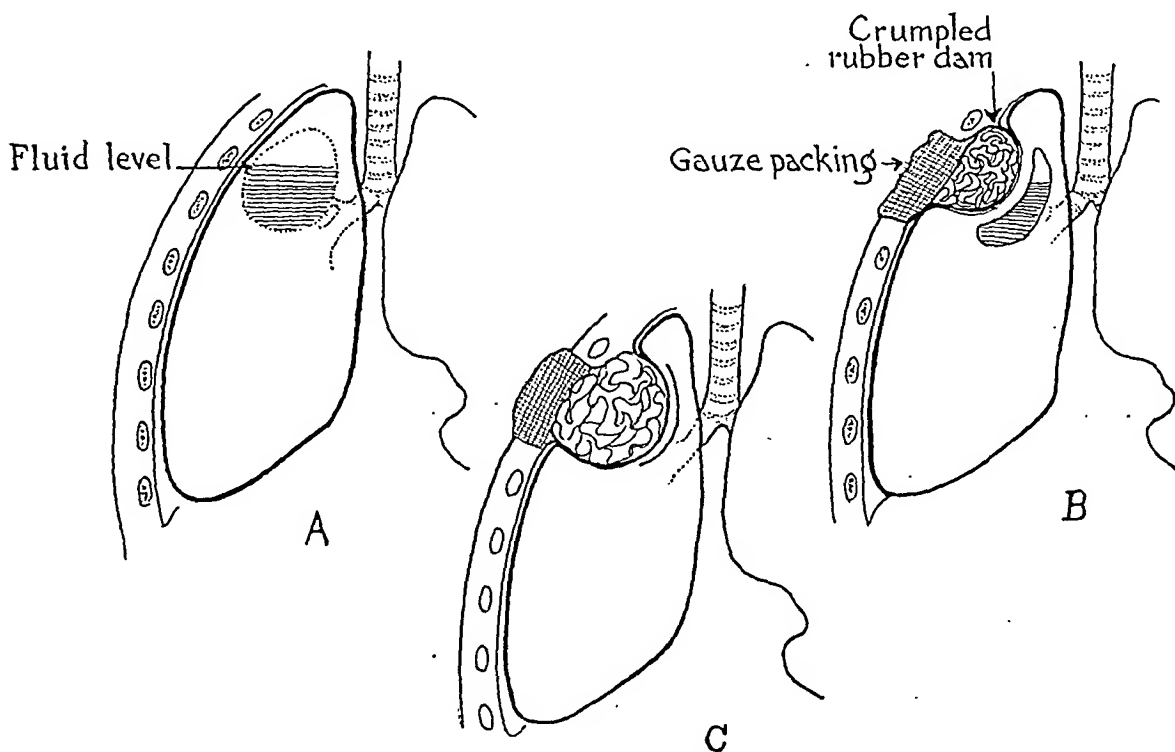


FIG. 12.—A. Represents large apical cavity. B. Subperiosteal resection of two ribs. The soft parts including periosteum forced inward. The extrapleural cavity thus formed is firmly packed with crumpled rubber dam, a pad of gauze on the outside to hold the rubber in place. The section of the cavity now has become crescentic. C. Four days later, the elastic expanding force of the rubber has greatly enlarged the extrapleural space compressing the pulmonary cavity into a curved slit. (See text.) Note: In typical apicolysis the entire pulmonary apex is pushed downward, not as represented here.

pleural exudate stiffens holding the lung in greater rigidity. It will, of course, be understood that in closed pneumothorax we are dealing with a compressible medium instead of an incompressible one such as pus or serum. Therefore, in open pneumothorax or more usually pyopneumothorax, such as is found in drained tuberculous empyema, it is but necessary to obliterate completely the dead space if we are to attain immobility of the lung; or motion of the lung may be already limited by confining membrane so tough and fibrous that respiratory motions are negligible.

II. *Drainage*.—Surgical drainage in pulmonary suppuration may be divided into two classes: A. Drainage through the bronchial tree by way of the mouth (obliteration). B. Direct drainage through the chest wall.

A. *Drainage of Pulmonary Cavities by Obliteration*.—Let us suppose that the patient is expectorating freely from the cavity itself but on account of its form or its position this cavity cannot be continuously emptied. If

the lung contains many of these spaces and its contents cannot be effectively evacuated by the more usual intrapleural means such as pneumothorax, posture, etc., clearly some form of thoracoplasty will be demanded. Not infrequently, however, we find

a single large cavity in the upper chest with the lower part of the lung revealing little evidence of disease and well able to function. The mechanical principle here employed would depend upon the possibility of draining the cavity through the bronchus by forcible compression. If this is not possible and the patient suffers from cough with profuse expectoration or

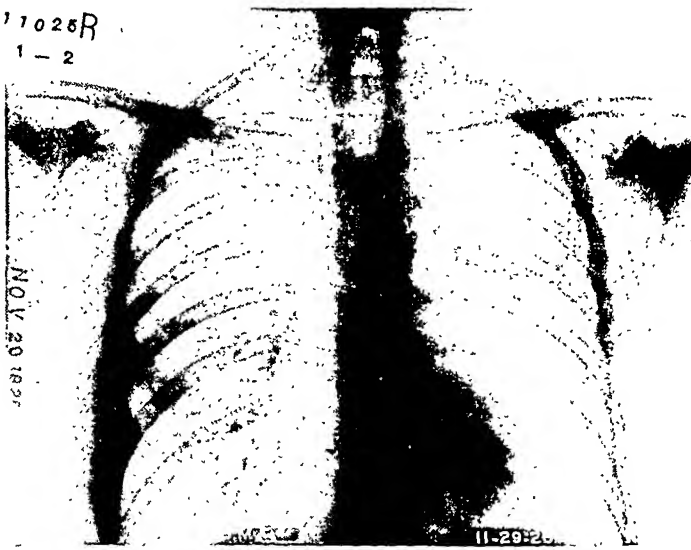


FIG. 13.—A case in which the procedure (Fig. 12) was employed. Enormous upper lobe tuberculous empty cavity. (Seen from in front.)

toxæmia, drainage into the outer world by pneumonotomy must be secured. Both these methods will be briefly discussed.

*Mechanical Compression.*—The first attempt should be by posterior thoracoplasty of the upper five or six ribs. If this does not produce sufficient reduction in the size of the cavity an extrapleural direct compression should be attempted. Now, in complete thoracoplastic operations it is often found that a large upper lung cavity has not been obliterated, although the lower part of the chest shows great reduction in capacity. An explanation for this phenomenon has been offered in a former paragraph, but may be repeated for emphasis. Ordinarily the negative pressure within the pleural sac tends to contract the thorax when the ribs have been mobilized. This suction being absent in the cavity because of normal air pressure, the original



FIG. 14.—Same patient following thoracoplasty of upper eight ribs. Two fluid levels are now seen. Note that collapse is less efficient in the upper chest than below.

volume of the latter shows little tendency to reduction. The space must, therefore, be forcibly obliterated. The methods which promise the best results are known as Apicolysis, by which an extrapleural space is made, the upper part of the lung being pushed downward and inward, and is permanently maintained by a plug of foreign material, the chest wall being then completely closed. In a modification of this procedure the extrapleural space over the cavity is filled with a packing, leaving the wound open. The packing is changed every two or three days until cicatricial tissue has

formed, together with new bone from the dislocated costal periosteum. Thus a firm barrier is secured which prevents the reëxpansion of the cavity.

I have found that in performing this type of apicolysis the use of a crumpled



FIG. 16.—Apicolysis with iodoformized wax filling. (See text.)

rubber dam packed in this manner exerts a strong elastic force gradually but surely enlarging the space which it occupies. (Fig. 12.)

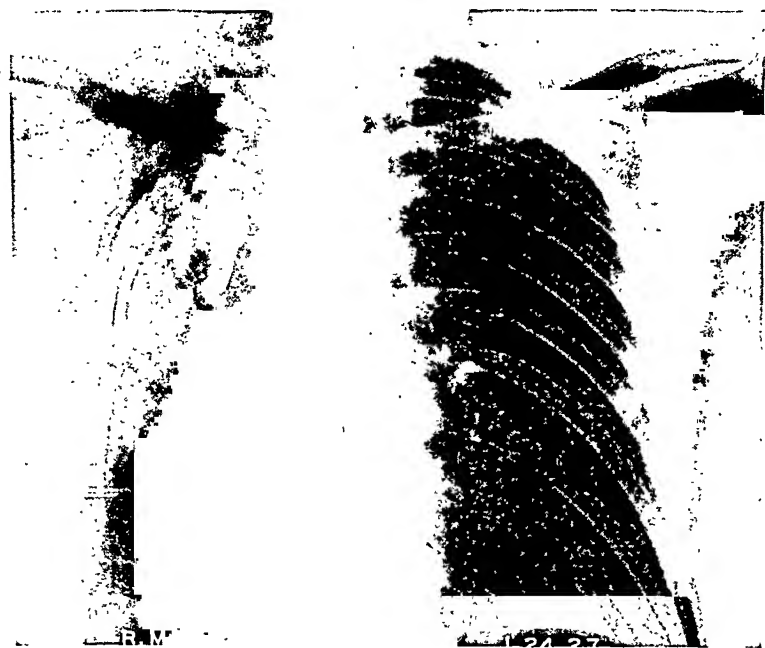


FIG. 15.—Same patient (seen from behind) modified apicolysis has greatly reduced the cavity. In transverse diameter this has been reduced by about three-quarters. In cubic capacity the reduction is, of course, very much greater. This picture was made soon after the operation. The cavity has since become a mere slit.

plug of rubber dam pushed firmly into the extrapleural cavity and covered with a gauze packing, the whole held in place by temporary skin sutures for three or four days, will greatly increase the efficiency of the apicolysis. In four days, when the sutures are removed and the gauze and rubber dam taken out, it will be found that we have secured a much larger extrapleural chamber than that which was made at the time of the operation. The

I have found this method of filling an upper half thoracoplasty in apicolysis efficient, although the period of convalescence, with the frequent packings, is long and may become irksome. As soon as the wall of the cavity no longer approaches the surface when the patient strains or coughs, the packing may be omitted and the wound allowed to close. A deep depression lined with skin marks the final result. Figures 16, 17 and 18 exemplify a case in which this method was employed. Figure 16 shows an iodoformized temporary wax filling in place, which I then employed instead of the preferable rubber dam.



FIG. 17.—Photograph of patient after apicolysis.

Figures 17 and 18 are photographs of the patient after recovery. The lower part of the lung is functioning perfectly and the patient is clinically well. He has married with the approval of Doctor Waters, of Loomis Sanatorium, a most conservative physician.

Another method, not quite so radical as those just described but much simpler and, in suitable cases, quite efficient, was first described by Dr. E. S. Welles, of Saranac Lake (*Archives of Surgery*, vol. xiv, No. 1, Part 2).

I have applied this method in three cases with good immediate results. Its technic is simple and there is the additional benefit that it requires but a few days of hospitalization. Briefly, the operation as I have performed it may be described as follows:

With the patient's arm above the head, the incision is made from near the apex of the axilla down along the anterior axillary line. When desirable this incision may be continued around the lower mammary fold so as to conceal an otherwise obtrusive part of the scar. (Fig. 19.) The posterior flap is dissected away from the ribs and the anterior flap is retracted, lifting the mamma from the pectoralis major muscle as far as may be necessary. The patient's arm is then placed against the chest, thus loosening the border of the pectoralis major which can now be retracted far toward the median



FIG. 18.—Same case, lateral view.

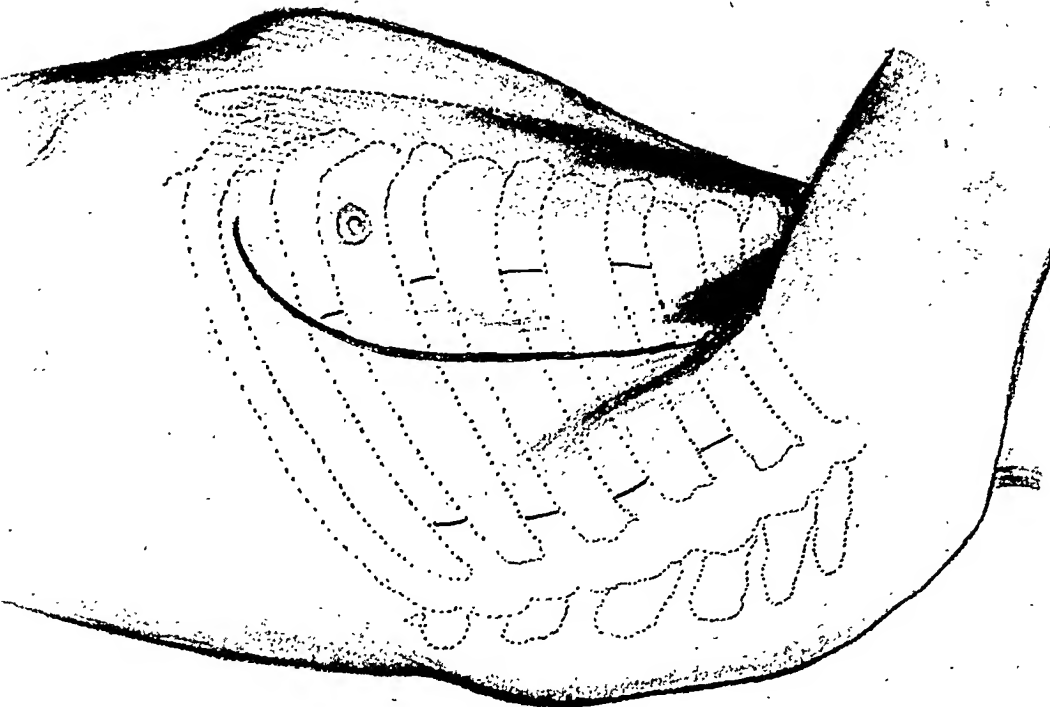


FIG. 19.—Welles's thoracoplasty. Left paravertebral thoracoplasty has previously been done. The mass of fused intercostal bone is seen in front of the vertebral spines. Dotted lines diagrammatically represent the ribs, the short solid lines indicating the present resections.

line, affording plenty of space for the remainder of the operation. Sections of the ribs, as many as seem necessary, are then removed, stopping short of the costal cartilages, but going back as far as the union of the ribs which followed the original thoracoplasty. All periosteum is conserved. The pleura, of course, uninvaded, is carefully stripped from the ribs and the flaccid chest wall being pushed inward and backward, a deep depression is formed over the entire exposed area. Immediately there is free motion of

this part of the thoracic wall, the area being sucked in on inspiration and forced out on expiration. The two flaps formed by skin and underlying tissues are united with a few interrupted through-and-through sutures and more perfect approximation is made with metal clips or fine silk stitches. A narrow tube to drain away the serum is led out of the lower part of the wound and may be removed in forty-eight hours. Gentle but firm gauze pressure is applied as a dressing and held in place with elastic adhesive plaster (Elastikon). Union will be sufficiently firm in four or five days to permit the beginning of the next stage in the treatment which is to exert continuous elastic force upon

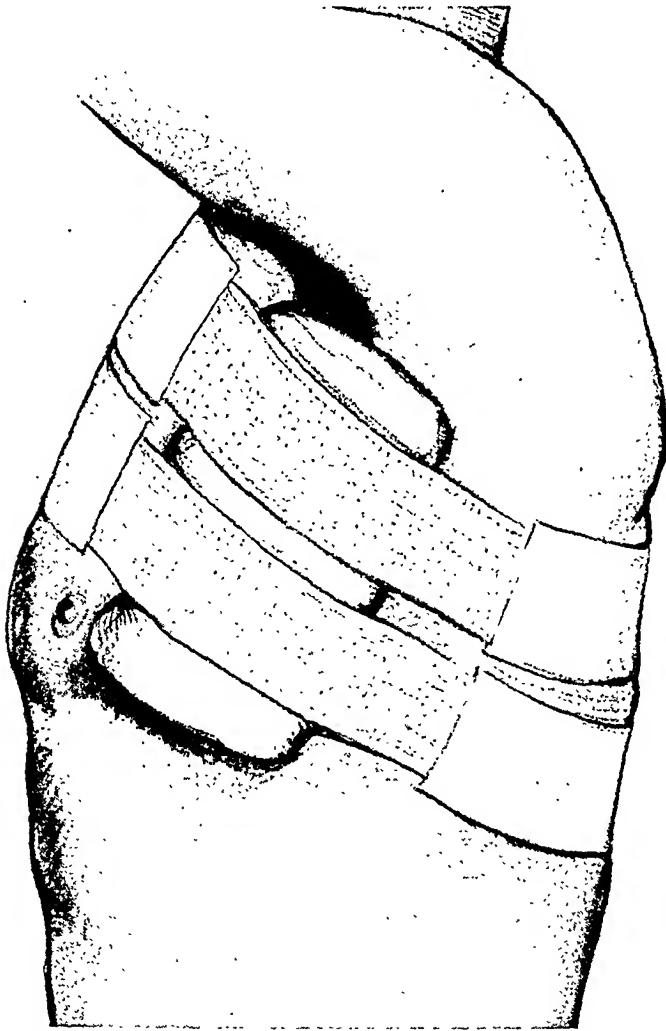


FIG. 20.—Compressing pillow of rubber dam and gauze maintaining the hollow formed by Welles's thoracoplasty. Pillow held firmly by strips of elastikon reinforced at each extremity with adhesive plaster.

the mobilized part of the thorax and to maintain its concavity until the formation of bony plates from the mobilized costal periosteum shall have stiffened the walls to resist coughing and straining. This is accomplished by enclosing a large crumpled mass of rubber dam or a rubber bath sponge in a gauze covering and strapping it in place with adhesive plaster. (Fig. 20.) The gauze covering should consist of several layers and is used so that the skin will not become macerated by contact with rubber. Figure 22 is from a photograph of one of my patients.



I have not made use of this procedure as a primary operation to obliterate an apical cavity and I think its application here would be very limited. My cases have all followed paravertebral thoracoplasty.

*B. Drainage of Pulmonary Tuberculous Cavities Through the Chest Wall.*—Opening a tuberculous cavity in the lung should be avoided if drainage by compression can be accomplished. It is not, however, the calamity which it was formerly believed to be. Sauerbruch, having accidentally caused a perforation, made the best of it and found that the drainage thus afforded was of considerable benefit.

In one of my cases when the bronchial exit of a cavity became angulated or plugged as the result of a distortion by paravertebral thoracoplasty, the patient at once became profoundly septic with high fever and I was forced to drain. This I did by resecting a rib contiguous with the thoracoplastic wound and entering bluntly the now putrid abscess which before had been recognized as a typical tuberculous one. This patient has done extremely well and healing proceeded slowly, but so steadily that it became difficult to maintain

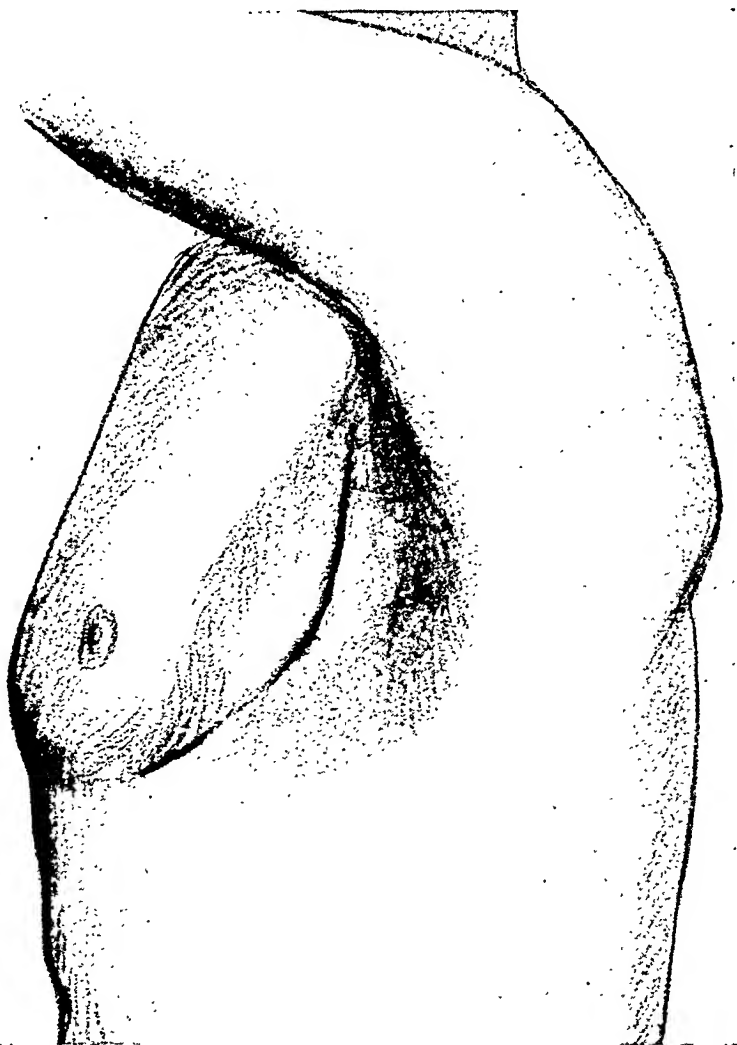


FIG. 21.—Wound healed and result of compression demonstrated.

the fistula which finally closed. It is more than four years since the operation. The patient is afebrile most of the time and is up and about, but there is still some irritative cough. She is well nourished and X-ray study indicates that the walls of the cavity are probably in contact.

It is interesting to observe that this opening into a chronic tuberculous hollow within the lung showed an almost unpreventable disposition to close. I believe that, with our present knowledge of phthisis, the actual drainage of cavities of this kind should be a last resort, but that we need not unreasonably fear it.

III. In tuberculosis of the lungs we also may have to deal with conditions demanding the following:

A. Drainage of the pleural sac, no thoracic opening—(a) without bronchopleural fistula, (b) with bronchopleural fistula.

B. Drainage of an open tuberculous empyema—(a) without bronchial fistula, (b) with bronchial fistula.

A. *Drainage of Pleural Sac When Chest Wall is Intact.*—(1) Without Bronchopleural Fistula: We have here virtually an ordinary empyema on a tuberculous base, with or without mixed infection. These cases are often



FIG. 22.—Photograph of a patient upon whom the operation (Welles's) was done. The scar shows an additional skin incision.

of extreme chronicity even running into years. The patients are not confined to bed but, on the contrary, may feel well and able to work. It appears to be nature's method for producing intrapleural pulmonary collapse. There is little or no cough. The pleura becomes thick and stiffened and there may be no real reason why anything should be done to change the status.

With the emptying of the chest, by aspiration or otherwise, there is a

tendency for expansion of the diseased lung and this may be followed by a recrudescence of the active tuberculosis.

Occasionally, however, these collections of fluid very slowly increase pushing the mediastinum toward the healthy side and encroaching upon the functions of the mediastinal viscera and the opposite lung. There is increasing dyspnoea, then cyanosis, and if nothing is done for relief, death will follow. When treatment is necessary in these cases, a simple form of valvular drainage is to be preferred to free incision or forcible aspiration.

A method which I have found useful is to insert through a cannula, a multifenestrated small catheter, the cannula then being removed. A very thin finger cot attached to the outer end of the catheter and then nicked with scissors makes an efficient valve, preventing the entrance of air while permitting the escape of fluid and such air as may have accidentally been admitted. The end of the tube with the finger cot should hang in a container of some sort, say a small rubber bag or even a test tube, according to the quantity of discharge; but it must be arranged so that air can circulate between the tube and the neck of the bottle or other receptacle. (Fig. 23.)

The patient may be out of bed and soon learns to keep his dressing in order. The physician should make an inspection every few days. The

## OPERATIVE TREATMENT OF PULMONARY TUBERCULOSIS

tendency is for the lung to expand gradually. Cough may appear with or without fever and in this case a thoracoplastic operation is required to obliterate the pleural space and put the lung permanently out of commission. At any rate the problem has now become one of ordinary tuberculous empyema.

(2) With Bronchopleural Fistula: This is usually the result of the perforation of a tuberculous cavity into the pleural sac. There is mixed infection, with air as well as pus present. When there is valvular action of the bronchial fistula a dangerous tense pneumothorax may appear calling for immediate relief by incision or by puncture with a trocar. (See Fig. 23.)

In any event, when drainage by way of the bronchial opening is insufficient, which is usually the case, thoracotomy with or without rib resection must be performed for external drainage. Subsequent treatment need not be discussed here.

A test may be made of the closure of the bronchopleural fistula by injecting a little dye, such as 1-5000 gentian violet, into the pleura and plac-

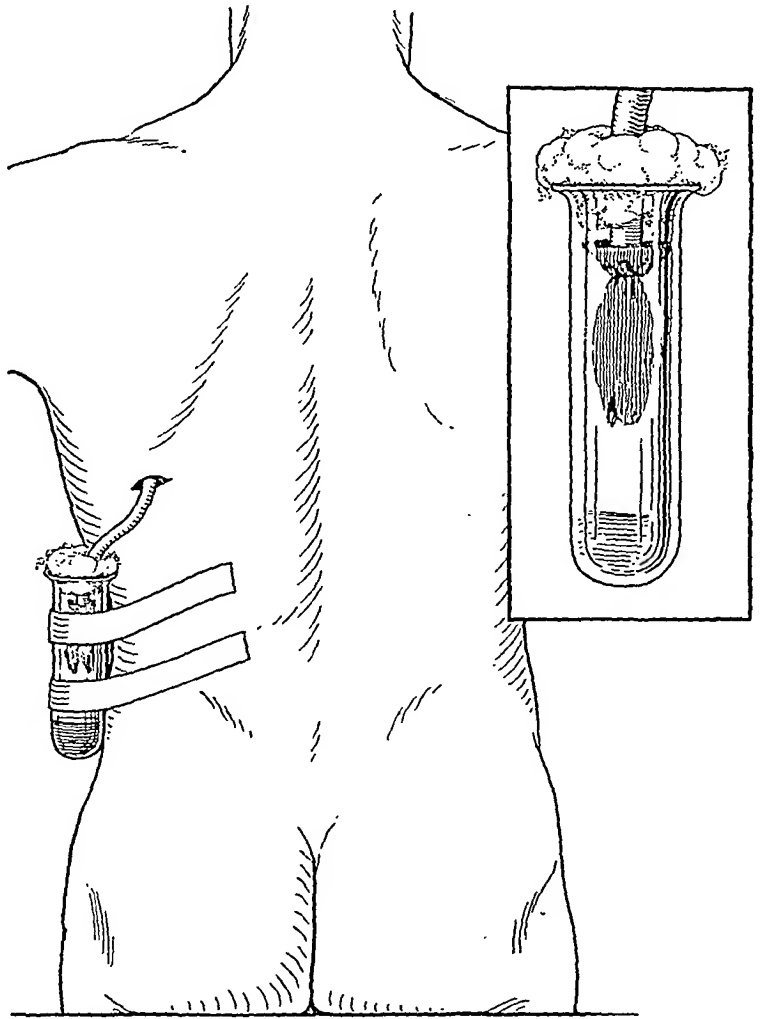


FIG. 23.—Air-tight valvular drainage of tuberculous empyema or of pyopneumothorax, arranged for ambulant patient. This is also applicable to certain nontuberculous cases. The insert is a closer view of the detail.

ing the patient in many postures especially lying in bed with the head low, both prone and supine, and noting whether the sputum is colored by the dye. Then, or even without this test, thoracoplasty may be employed to reduce the size of the infected pleural space or to effect obliteration.

**B. Drainage of an Open Tuberculous Empyema.**—(1) Without Bronchial Fistula: When there is no demonstrable bronchopleural fistula, the problem is to close a simple drained tuberculous empyema. The lung mobilization, so valuable in non-tuberculous pyothorax, becomes here a dangerous and non-permissible operation for, not only will there be spreading of tuberculous infection on account of the reestablishment of pulmonary motion, but

the opening of many lymph and blood channels in indurated tissue is very apt to be followed by the entrance of air, toxins or even emboli of considerable size with lodgement in distant regions, especially in the brain. The lung and its coverings are, therefore, carefully guarded from traumatism and the chest wall, mobilized by multiple rib resection, is made to approach the midline of the body. (Fig. 24.)

(2) With Bronchial Fistula: In pulmonary tuberculosis with a bronchial

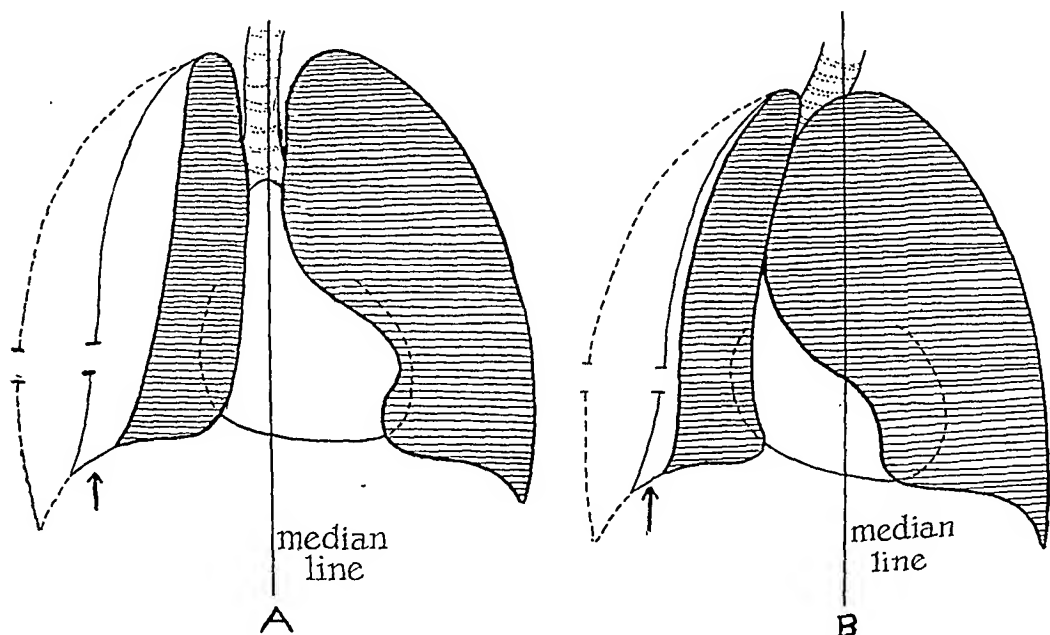


FIG. 24.—Obliteration of simple tuberculous empyema. A. Thoracoplasty has moved the normal chest wall (dotted line) toward the midline of the body, reducing the size of the pleural sac. The lung (shaded portion) has been firmly collapsed by the former tense empyema. B. Pleural cavity still further diminished by gradual encroachment of the better lung which has pushed the mediastinum and its organs toward the diseased side. (Arrows indicate pleural cavity).

fistula in an open empyema cavity the cure is tedious. It may require many operations to obliterate the pleural sac and the cavity within the lung. This is all which can be done from the purely mechanical side. There must be perfect drainage from the lowermost part of the wound and our hope will then lie in the final obliteration of the recess within the pleural cavity by granulation. No method is known by which the bronchopleural fistula can be mechanically closed so that it will heal. We must depend upon supplying proper conditions for the disinfection of the wound and trust in the restorative power of the tissues themselves to accomplish full repair.

#### SUMMARY

1. Rest and drainage are the two important mechanical objects of the surgery of pulmonary phthisis.
2. Rest may be temporary and in varying degrees, or it may be permanent in varying degrees even to the complete abolishment of lung function.
3. There are extrathoracic methods. Those relating to the phrenic nerve are described.

## OPERATIVE TREATMENT OF PULMONARY TUBERCULOSIS

4. Operations upon the thorax itself deal with rest and with forms of drainage, either by way of the air passages and mouth or out into the world.

5. The obliteration of pulmonary cavities or of diseased areas of the pleural sac are described. Speaking broadly, this obliteration is a form of drainage.

6. Pulmonary collapse and compression are aided by the suction power of negative intrapleural pneumatic tension. This negative pressure cannot operate when there is an air passage through the chest wall. It cannot operate in the case of large intrapulmonary cavities which directly open into the normal outside air through a large bronchus.

7. Methods of operation are described and there is a discussion of the mechanical principles on which they are founded.

## OPERATIONS AS AIDS IN THE TREATMENT OF PLEUROPULMONARY TUBERCULOSIS<sup>1</sup>

BY JOHN LAWRENCE YATES, M.D.

OF MILWAUKEE, WIS.

WE PURPOSE to establish three significant but unrecognized facts concerning the treatment of those suffering from pleuropulmonary tuberculosis. (1) To show why simple operations used promptly, in proper sequence, and in conjunction with other measures will provide each patient, not already lethally affected, with every opportunity for undelayed recovery, for arrest or retardation of the progress of his disease, whatever be the nature or the stage of the malady. (2) To show why neither surgical nor non-surgical measures alone can fulfill these therapeutic requirements. (3) To show how beneficent operations have been performed without imposing intolerable burdens upon even weakened patients and with only the limited dangers of wound infection, hemorrhage, thrombosis, embolism, and pneumothorax.

I. Pathogenic tubercle bacilli are deposited so frequently upon epithelial surfaces within the lungs of most adults and many children that their presence is quite constant. Some of the organisms enter tissues and establish focal infections. Because of effective powers of resistance, defense, and repair, the majority are insusceptible. They are able to suppress the invading parasites without developing signs or symptoms of infection. The healing is so excellent that the residual pulmonary lesions are either undemonstrable post-mortem or are too restricted to have hampered respiration. The lesions rarely, if ever, contain living bacilli.

Four grades of susceptibility occur among the minority who develop the disease. (1) The least susceptible recover sooner or later, however treated or maltreated. Healing is sound. Although the lesions in the lung are demonstrable intra vitam and postmortem, they are too restricted to hamper respiration materially. The residual lesions seldom contain living organisms. A proportion of these individuals acquire insusceptibility which is often lasting. (2) Those of moderate susceptibility will recover if properly treated, but only after longer periods of disability. The healing is good, but the greater extent of the residual lesions reduces pulmonary elasticity enough to impair respiration and curtail physical activity. Such residual lesions often contain living organisms. Some of these patients acquire increased resistance that may even approach insusceptibility, but it is likely to be transient. (3) Those of immoderate susceptibility cannot recover completely. Appropriate therapy enables them to retard, perhaps arrest, the progress of their disease after prolonged periods of rather complete disability. Respiration is so restricted by cicatrization of lung and pleura that physical

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<sup>1</sup> Read before the American Surgical Association, May 12, 1927.

capacity is decidedly limited. The residual lesions contain living organisms quite constantly. Some recover sufficiently to enter gainful occupations without endangering their associates. Some develop decreased susceptibility, but this improvement is apt to be evanescent. (4) The progress of disease in those of extreme susceptibility can be barely retarded. On the contrary, unhygienic modes of living transform lesser grades of insusceptibility into susceptibility and intensify the degrees of susceptibility. Similarly, delayed, inappropriate, or prematurely discontinued treatment sacrifices opportunities for recovery or for arrest or retardation of the progress of the disease.

Prophylaxis is realized through hygienic modes of living that augment and conserve the powers of resistance, defense, and repair, thereby increasing insusceptibility and decreasing susceptibility. The effect upon lungs is to develop and to maintain high normal vital capacity. Treatment employs hygienic and other measures to reduce susceptibility. When effective it promotes healing of involved portions of lung with the least amount of scar and protects the uninvolved portions. The effect upon the lung is to restore and to maintain as high vital capacity as the residual cicatrices permit. Thus there is a desirable element of prevention in treatment. The earlier treatment is instituted, the larger the element of protection, the more promptly improvement is attained, the less the duration of immediate disability, the degree of ultimate disability, and the liability to reinfection or to recrudescence of previous infection.

Vital capacity, the largest volume of air that can be expired after full inspiration, is commensurate with the efficacy of the function of external respiration. External respiration, which is the basic function of the living, is produced by the combined activities of the breathing apparatus and of the blood-forming and blood-delivering structures that compose the circulatory apparatus. External respiration determines individual competence or the capacity to develop energy in excess of the amount required to support inactive existence. The degree of competence determines the capacity to combat disease. Consequently, none of the essentials in the treatment of intrathoracic diseases can be neglected if the measures employed keep vital capacity as high as feasible during the aggressive stage of the process and return it to normal during the regressive stage.<sup>2</sup> Hence it is necessary merely to recognize the untoward influences that reduce vital capacity in order to find the measures that will assist patients to combat those influences and simultaneously to discover when and how the measures should be utilized.

Normal vital capacity is possible as long as the breathing unit is intact, *i.e.*, pleuropulmonary elasticity is unimpaired, intrapleural negative pressures are unaltered, and movements of the thoracic parietes, particularly the diaphragm, are unrestricted *provided* the circulatory unit is uninjured so that

<sup>2</sup> The Significance of Vital Capacity in Intrathoracic Therapy. Archives of Surgery, 1925, vol. x, p. 471. The Significance of Vital Capacity in Intrathoracic Therapy. Archives of Surgery, 1926, vol. xii, p. 257.

suitable volumes of good blood are delivered under appropriate pressures through the pulmonary and bronchial arteries.

The nature of injuries inflicted by tuberculosis and by treatment that impairs the functions of the structures constituting the breathing and circulatory apparatuses, explanation of the effects of the injuries, and an outline of the means to modify or to avoid them will be considered in reference to (A) the breathing unit (pleuropulmonary elasticity, intrapleural pressures, movements of parietes) and (B) the circulatory unit (formation and delivery of blood through pulmonary and bronchial arteries).

#### A. BREATHING UNIT

Pleuropulmonary elasticity is reduced by (1) lesions of the parenchyma, (2) thickening of the visceral pleura and adhesions of the visceral to parietal pleura, and (3) protracted collapse and compression of the lung that cause permanent contraction.

(1) Lesions of the parenchyma consist of the reactions of the divers tissue cells to the action of irritants emanating from tubercle bacilli and of cellular and non-cellular elements derived from blood. The characteristics of the least unfavorable lesions are a more active proliferation of cells other than connective tissue, active hyperæmia, and eventual healing with minimal fibrosis. More unfavorable lesions, though they be the best attainable, are developed when there is a less active proliferation of the epithelial and endothelial cells, and a progressive fibrosis is accompanied or provoked by hyperæmia instead of hyperæmia.

Lung parenchyma possesses extraordinarily high power of resistance and repair. This native power differs insignificantly among individuals save as it is vitiated by emphysema, cicatrices, anæmia, which includes subnormalities in corpuscles and plasma, and by passive congestion, each of which, it should be noted, impairs external respiration and reduces vital capacity. Repeated deposition of more or less virulent tubercle bacilli upon epithelial surfaces of the lung is inevitable, and some infection is certain. The nature of the resultant lesions is determined very largely by the quality and quantity of blood delivered to the lung. Wherefore the healing of lesions can be promoted in three ways: primarily, by improving the quality of blood in circulation and increasing the unit volume of blood delivered to affected lung; secondarily, by so altering intrathoracic tension that the natural contraction of fibrous tissue can collapse intrapulmonary cavities or that reëxpansion of lung can obliterate intrapleural cavities; and, thirdly, if these are inadequate, by destroying such structures as prevent the healing of menacing and otherwise irreparable lesions.

All patients benefit by having the quality of blood improved and the unit volume delivered to involved lung increased. Those having moderately advanced lesions require the additional assistance provided by lesser alterations of intrathoracic tension, and those harboring advanced lesions need greater alterations in tension and perhaps the destruction of tissue.



(2) Visceral pleura is thickened, and adherent pleuritis is provoked by irritants extending to its under surface from lesions of the subjacent parenchyma or delivered upon its outer surface by effusions. Parenchymal lesions have been discussed. Surface irritants come from pleuritic effusions, from pneumothorax, be it spontaneous or induced, and affect both visceral and parietal reflexions of the pleura. Acute pleuritis subsides after the formation of adhesions.<sup>3</sup> The sooner inflamed pleural surfaces, separated by effusions or air, are reapposed and maintained in contact, the more rapidly inflammation subsides, the less the thickening, and the greater the likelihood of restoration of a pleural cavity. The powers of resistance and repair of pleuræ depend upon the quality and quantity of blood they receive, the greater power being supplied by the visceral reflexion.

Prevention and relief of acute pleuritis are attainable by improving the quality of blood in circulation and increasing the volume of blood delivered through the bronchial arteries which supply the visceral pleura in man, by restricting the excursions of the lung during acute phases of inflammation so as to facilitate formation of adhesions, and, if the pleural reflexions are separated by air or fluid, by reapposing them gradually by repeated or continuous aspiration. After the chronic stage of inflammation is established, excursions of parietes and of lung should be slowly increased by appropriate exercises in order to stretch adhesions and gradually disrupt them because this is one means to restore the integrity of serous membranes. When lung has become so retracted after prolonged collapse or compression that reëxpansion is impossible, some form of thoracoplasty must be employed to reappose the pleural surfaces.<sup>4</sup>

(3) Collapse and compression of lung are the more advanced stages of deflation. Deflation develops as intrapleural negative pressures are reduced but not abolished. Collapse obtains when negative pressures are neutralized and the lung is under atmospheric pressure. Compression increases as pressures exceed that of an atmosphere. Respiratory excursions of lung in deflation are restricted; in collapse, are quiet; and in compression, are entirely inhibited. The volume of collapsed lung is the resultant of contractile force (elastic recoil) and of expansile forces (the expansion produced by the blood-pressure in the pulmonary artery, the six-fold greater systemic pressure in the bronchial artery, and by the positive intrabronchial air pressure of forced expiration). The volume of compressed lung is less than that of collapsed lung because positive pressure is added to the contraction pro-

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<sup>3</sup> Wounds of the Thorax from *The Oxford Surgery*, 1921.

<sup>4</sup> The advocates of induced pneumothorax recognize the certainty of provoking pleuritis by the introduction of a foreign substance, the need to aspirate the pleuritic effusions that occur with some frequency after pneumothorax has been established, the greater efficacy of this procedure when intrapleural negative pressures are reduced but not abolished, and the impossibility of maintaining constantly the desired level of reduction in negative pressures. Enthusiasm for a means of proved virtue has blinded the majority to its vices which can be eliminated by using a method that accentuates natural responses without introducing a morbid condition.

duced by elastic recoil and expansile forces are no greater. Fibrosis present in diseased lung increases elastic recoil and tends further to diminish the volume of diseased lung in both collapse and compression. Fixation of even normal lung in collapse or compression leads eventually to such firm contraction of its component structures as to prevent reinflation if artificial pneumothorax is employed. Correction of collapse and compression is achieved by timely aspiration of air or fluid, which should be withdrawn or allowed to escape so gradually as to avoid cardiac disturbances. When permanent collapse is to be established by thoracoplasty, it should be produced in stages to limit the amount of readjustment required at any one time and to determine when every benefit has been attained so that needless mutilation can be avoided. Compression is caused by pressure exceeding an atmosphere. It is not produced by ordinary thoracoplastic operations. It should not be occasioned by extraordinary procedures because it provokes ischæmia and increases cardiac labor.

*Intrapleural Negative Pressure.*—Negative pressure arises from the elastic recoil of the lung acting in a vacuum when the pleural reflexions are not adherent. It fluctuates with grades of inflation and of deflation and is higher as inspiration increases and lower as expiration increases. Inspiration is produced by elevation of sternum and elevation and rotation of ribs, by widening of intercostal spaces, and by contraction of the diaphragm. Unforced expiration is caused by elastic recoil of lung and by a similarly elastic recoil of the parietes resulting from relaxation of muscles that induce inspiration reënforced by contraction of intercostal muscles. Fluctuations in negative pressure and in inflation and deflation of the lung are both reduced when movements of the parietes are restricted. It will be shown that the largest volume of blood is delivered to each unit volume of lung when the fluctuations in negative pressure and the excursions of the lung are restricted. Intrapleural negative pressure disappears with pleuritic adhesions. Inflation is effected by direct transmission of expansile force from parietes to lung. Unforced deflation is caused by elastic recoil of lung and parietes and by contraction of intercostal muscles. Pleuritic adhesions limit inflation because the pleural surfaces do not glide and parietal movements are restricted. Vital capacity is correspondingly reduced.

Restriction of pulmonary excursions to those just above and just below the mean is desirable in the aggressive stage of the disease. It can be accomplished by reducing intrapleural negative pressure either by the introduction of air that assures pleuritis or by the restriction of parietal mobility that increases protection against pleuritis. The latter means are equally applicable when pleuritic adhesions or sound judgment prevent the use of induced pneumothorax. Abolition of negative pressure is undesirable; creation of positive pressure is unwarranted.

*Movement of the Parietes.*—Excursion of the lung through all grades of inflation and deflation, and therefore vital capacity, is more dependent upon motions of the parietes than upon any other factor. Limitation of parietal

mobility is necessary during the aggressive stage of the disease because of its similar influence upon the range of pulmonary excursions. Restricted excursion reduces the rate of removal of toxic products, favors repairs mechanically, and vouchsafes the maximal blood supply that promotes sound healing. Parietal mobility is restricted automatically if there be acute pleural irritation. This is a natural defense response which develops spontaneously or can be provoked in man and other animals. Parietal mobility is usually insufficiently restricted in pulmonary tuberculosis because in earlier stages the pleura is not irritated and in later stages the pleural cavity is frequently obliterated. Motion of parietes can be limited to conform with propitious natural degrees of restriction by blocking nerve trunks transmitting motor impulses to the diaphragm. Paralysis and consequent atony of the diaphragm permit positive intra-abdominal pressure to displace it upward. Movements of the balance of the parietes of that side are automatically reduced, or, even if there be adhesions, lung volume is reduced, pulmonary excursions are limited to those just above and below the mean, and the physical conditions are established that nature has proved most effective in promoting pleuropulmonary resistance, defense, and repair. There is another and equally noteworthy aspect. Persistence of parietal immobility beyond recovery is quite as undesirable as is its absence during illness. Vital capacity is lowered, and the individual's competence is diminished. Reduction in vital capacity is equivalent to the limitation of motion of the diaphragm which is more influential than the costal parietes upon pulmonary excursions. Consequently, as long as recovery is a possibility paralysis of the diaphragm should be induced by temporary blocking of the phrenic nerve (phrenemphraxis) which can be made permanent later if necessary by exeresis or phrenisectomy that should be used primarily only when restoration of function is undesirable. Similarly, costectomies should not be performed until the need of this means of aiding healing is established and then without delay. Thoracoplasty can but alter intrathoracic tension. The utmost accomplishment is to place an entire lung in collapse. Patients who need thoracoplasty are quite certain to have developed adhesive pleuritis at least over the most affected portion of their lung. Wide resection of ribs overlying the lung most involved promises the largest benefits and are the ribs to be excised first. The number of ribs removed should be as few as needed to promote healing because every additional rib removed imposes a reduction in vital capacity, greater mutilation, and worse than needless immediate operative risks.

#### B. CIRCULATORY UNIT—FORMATION AND DELIVERY OF BLOOD

*Blood Formation.*—Continued production of each of the corpuscles and of each of the constituents of blood plasma in numbers and in amounts suited to age, sex, habits, and environment is essential to preserve health, to afford protection against pathogenic agencies, and to permit recovery from disease when that protection has been inadequate. Blood corpuscles and plasma are formed in part in the lymphatic and the balance in the extra-

lymphatic portions of the circulatory apparatus. The cellular and non-cellular elements produced by extralymphatic structures are the more efficacious in affording protection and defense against parasites that provide acute maladies, in affording resistance against the initial action of parasites that provoke chronic diseases and against the subsequent increased action of such parasites as introduce acute exacerbations in the course of chronic ailments, and in promoting the earlier phases of repair following more abrupt injuries to tissues. The cellular and non-cellular elements produced by the lymphatic structures are more efficacious in providing defense against parasites that provoke chronic affections subsequent to their initial action or to action introducing acute exacerbations, in producing immunity against certain organisms that initially provoke acute maladies, *e.g.*, scarlet fever, and in promoting the later phases of repair after abrupt injuries to tissues or virtually all phases of repair when the injuries are inflicted gradually. Protection and defense provided by blood elements produced by neither the lymphatic nor the extralymphatic structures are efficacious without the other, and similarly the corpuscles alone or the plasma constituents alone are inefficacious. The numbers, proportions, and physical characteristics indicate the functional capacity of each of the corpuscles in circulation and also the functional capacity of each of the five groups of hæmocytoblasts that form the corpuscles. If hæmocytoblasts are competent, the number and physical status of their corresponding daughter cells are normal or above normal. If they are incompetent, the number of daughter cells is below normal or abnormally increased, and they are altered in size and in structure. The responses of hæmocytoblasts to irritants disseminated through the circulation from local lesions will be favorable or unfavorable according as the cells are competent or incompetent. Incompetence of mother cells is either reparable and recovery is possible or irreparable and recovery is impossible. Incompetence can be remedied by reducing intoxication, improving nutrition, and, when necessary, supplying corpuscles through transfusion to allow the mother cells to rest and recuperate. The evil effects of irremediable incompetence of hæmocytoblasts can be minimized by repeated transfusion that supply enough cells to reduce deficits. This is urgently needed when oxygen-carrying power is curtailed by erythrocytopænia and hæmoglobinæmia and when there are deficits in other corpuscles particularly needed in defense, such as lymphocytes and platelets, else arrest or retardation of the progress of the disease is unattainable. All constituents of the plasma are necessary, but the ones most significant in disease are those providing ingesta—water, salts, and nutrition, the specific and non-specific antibodies are as far as can be estimated at present commensurate sites and that tend to neutralize or inactivate noxious products of parasites or of tissue degeneration provoked by parasites. Deficits in specific and non-specific antibodies are so far as can be estimated at present commensurate with the degree and nature of acceleration of sedimentation rates though these deficits are not the sole causes of the increased rapidity of sedimentation. Incompetence of the cells elaborating antibodies are responsible for the deficits

in these substances, and, like corresponding incompetence of the mother cells of the divers blood corpuscles, the incompetence is reparable or irreparable. Moreover, the remedies are similar. Rest, fresh air, sunshine, and suitable diets are needed. Deficits in water, salts, and glucose that cannot be supplied through the digestive apparatus can be given intravenously and at the same time noxious substances in the blood are diluted and their elimination is facilitated. Oxygen-carrying power of the blood is as a rule materially reduced in the very patients who are deficient in their elaboration of antibodies. The oxygen-carrying power is raised and the antibody deficits are somewhat corrected by transfusion if donors are chosen who have unusually high antibody content in their blood, that is, blood from individuals of natural or recently acquired insusceptibility. Recovery is impossible if the antibody content remains low. Repeated transfusions are necessary and blood unmodified by anticoagulants must be employed because available anti-coagulants impair or destroy antibodies.

Insusceptibility, as well as the divers degrees of susceptibility to tuberculosis, is traceable, primarily, to the quality of blood in circulation, and, secondarily, to the volume of blood delivered through the bronchial and pulmonary arteries. Provision of means to treat patients requires recognition (1) of the nature and sources of deficits in corpuscles and in plasma elements which permit infection to become established, of the favorable and unfavorable responses developed by the various blood-forming structures according as patients are able or unable to control the subsequent evolution of disease, and (2) of the natural mechanism whereby delivery of blood is effected and modified spontaneously.

The numbers and characteristics of the corpuscles in patients at or soon after onset are usually but little altered save in acute pneumonic processes and when gross abnormalities of blood have been the predisposing agency. Limited neutrophilia, lymphocytosis, and increase in transitionals indicate favorable responses and vice versa. On the other hand, increased rates of sedimentation are quite constant. Evidence to date suggests that distortion of sedimentation is due largely to deficits in specific and non-specific antibodies which are caused by incompetence in lymphatic structures.<sup>5</sup>

As the evolution of the disease progresses, patients who effect favorable healing of their pulmonary lesions likewise develop favorable responses in their cellular and non-cellular blood constituents. Moreover patients so

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<sup>5</sup> Individuals inherit lymphatic tissue of different degrees of competence. More pronounced degrees of incompetence are noted in status lymphaticus. Functional capacity of lymphoid tissue differs with sexes and fluctuates with age, season, modes of living, and can be dissipated by overwork, by prolonged exposure to X-ray and radium, to certain coal-tar derivatives, and by lymphotoxic diseases, notably influenza. Normal fluctuations in the capacity of blood-forming elements in the lymphatic section of the circulatory apparatus and reduction in the competence of structures inherently less robust caused by usual and unusual stresses of life explain why some diseases, *e.g.*, tuberculosis and cancer, occur more frequently at certain ages and why by exception they develop at ages commonly exempt.

treated as to improve the quality of blood commonly effect better healing. The contrary is equally true. Patients whose pulmonary lesions are progressive are simultaneously progressing toward cachexia in which both cellular and non-cellular blood elements are distorted and most deficient. Patients in whom deterioration of their blood cannot be remedied are unable to arrest the progress of their pulmonary lesions.

Recovery is concomitant with or perhaps preceded by a reestablishment of a normal quality and volume of blood. Permanent insusceptibility results when the blood-forming organs, especially the lymphoid portions, instead of being subcompetent, have acquired a lasting competence. Transient insusceptibility or a state of evanescent increased resistance occurs when competence is not maintained or when it is but partially and temporarily realized. The status of the blood may be likened to the horse and the nature and extent of the pulmonary lesions to the cart. The roadway is rough, and the grade rises more or less unevenly. A weak horse cannot pull even a partially loaded cart uphill, and, if the load be too heavy, a strong horse will be exhausted. We must avoid placing the cart before the horse and over-rating the significance of either horse or cart. Means to strengthen the horse, *i.e.*, to improve the quality of blood, have been outlined. Means to reduce the load, *i.e.*, to decrease peripheral resistance to blood flow and to diminish the production and retard the absorption of noxious substances, are quite as helpful if they be provided without injuring the horse. The tendency is to concentrate attention upon the cart and to overlook the horse because a majority of patients are overburdened, some at onset, the balance when they appeal for help.

*Delivery of Blood Through the Pulmonary and Bronchial Arteries.*—The volume of blood delivered is determined by myocardial power, by the quality and quantity of blood in circulation, and by the peripheral resistance to the flow through the arteries.

Blood flow in the lesser circulation is controlled hydrodynamically. The blood delivered is to be aërated (external respiration) and does not supply lung structure with its bulk of nourishment. Peripheral resistance fluctuates with inflation and deflation. It is least at the mean between full inflation and full deflation. The larger vessels and the capillaries in the walls of air sacs are in this position neither the more elongated, as they are in inflation, nor the more tortuous, as they are in deflation. The unit volume of blood delivered to a unit volume of lung is not only greatest but also is delivered with the least cardiac effort. Fixation of a diseased lung in the mean position, although it would minimize both cardiac labor and the rate of absorption of noxious substances from lesions and hasten healing, is fortunately as impossible as it is undesirable. Non-use restricts the amount of blood delivered through the bronchial arteries which nourishes lung and visceral pleura and causes atrophy and consequent lessened resistance of pleuropulmonary structures. Resistance, defense, and repair are highest and are secured with the greatest possible economy when pulmonary excursions are restricted to those just above and below the mean. Such restriction, as stated above, is a natural

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defense reaction which can be imitated to a nicety by induced paralysis of the diaphragm.

Blood flow through the bronchial arteries, though modified to a degree by the physical conditions of inflation and deflation, is further influenced by vasomotor impulses. Amounts of blood delivered to lung structures and to visceral pleura are increased with activity and decreased with inactivity. They are likewise increased with the more active defense responses and diminished if these responses are of the less active, fibrosing type. Whatever be the nature of the process in the lung, defense and repair will be fostered by richer blood supplies, which will be provided most propitiously when pulmonary excursions are restricted but not abolished and with the least cardiac labor.

Thus far only the volume of blood delivered to an affected lung has been considered. The total volume of blood delivered through the lesser and greater circuits must be the same if life is to continue. Blood forced into pulmonary arteries takes paths of least resistance. If intracapillary resistance be increased by parenchymal lesions, by collapse or compression, a part of the blood that normally would pass through these vessels is diverted into adjacent capillaries offering less resistance. These capillaries are overfilled, and, because of the air-cell-capillary mechanism described by Dunham, the overfilling produces compensatory functional emphysema. This is nature's automatic device to maintain external respiration at a high level with a margin of safety in addition. The cost is an increment in cardiac labor.

The practical significance of these responses warrants emphasis. Normal folk have more than enough lung to aërate all the blood their hearts can deliver while their physical activities are uttermost, and more than thrice as much lung as is required to aërate the blood delivered while at rest. If the volume of lung structure destroyed by disease or inactivated by treatment exceeds the excess volume that provides the usual margin of safety, the limit of activities is correspondingly curtailed. Also any activity that requires pulmonary expansion above that of rest imposes an abnormally heavy burden upon the heart because an excess of functional emphysema must be provided in order to effect aëration. Paralysis of one side of the diaphragm reduces the upper limit of exertion approximately one-third if the heart is strong. If, in addition, the volume of lung is further reduced by costectomies, the handicap is increased. Each change in lung volume, be it an increase or a decrease, is accompanied by alterations in the distribution of blood within the lesser circuit and corresponding differences in heart work. Consequently, alterations in lung volume produced by aspiration of air or of pleuritic exudates, by the injection of air, or by costectomies should be made gradually. No functioning lung and no inactivated lung that can be aided to function again should be sacrificed except as a last resort.

II. Reasons why non-operative treatment alone or operative treatment alone must fail to satisfy therapeutic requirements and why those require-



ments will be fulfilled when proper non-operative and operative measures are promptly utilized in suitable combinations.

Experience has demonstrated that degrees of susceptibility of patients suffering from the disease in its incipient stage cannot be measured with dependable accuracy. The physical and mental states *at the time* of examination always can be estimated, but not the reserve powers which provide the margin of safety requisite to recovery. Two types of patients are illustrative of this fact. Some, apparently quite robust and likely to recover promptly, grow worse after longer or shorter intervals, however good be the initial care. Such individuals develop their maximum defense early, and subsequently the structures producing essential portions of that defense undergo progressive deterioration which at best can only be retarded. Others, obviously weakened and presumably incapable of developing adequate defense, need relatively little assistance to achieve recovery by virtue of the abundance of their reserve powers.

The proportions of patients who recover despite treatment and of those who need little help to achieve recovery are large enough to have obscured the significant issues. Attention has been centred rather upon successes, which are less creditable than is supposed, than upon failures and the need to explain and to remedy them. According to precedent, early treatment is expectant until after patients have demonstrated their incapacity to recover, and only then, when it may be and frequently is too late, attempts are made to provide additional assistance.

Non-operative and operative measures that will benefit each patient without being harmful to any are not employed from onset. Rest, particularly enforced mental inactivity, is often overdone; fresh air is provided through open windows instead of by living and sleeping outdoors; direct exposure to sunshine is denied or is overdone; diets are atrocious; good food, should it be purchased, is vitiated by mediocre cooks and less than mediocre serving; fresh fruits are deficient in quality and in quantity; sufficient amounts of good water are not provided; phrenemphraxis, or the less wholesome artificial pneumothorax, is delayed; transfusion of unmodified blood from well-selected donors is not even considered.

There is a large measure of grim humor in the insistent exhortations to send patients to sanatoria immediately a diagnosis is reasonably certain and then, through prejudice and procrastination, to sacrifice the invaluable element of prevention by failure to provide *all* means to expedite improvement and thereby curtail the duration of immediate and the extent of ultimate disabilities. The sublime touch of irony is to attribute unfavorable results entirely to individuals' lack of stamina or to their failure to submit gracefully to routine discipline.

The conditions attendant upon the treatment of patients in more advanced stages of the disease are not quite the same. They are naturally or have been forced into the more susceptible class. Their margins of safety are correspondingly narrowed. They no longer may be assisted by operations to



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avoid permanent disability; they must be assisted to recover despite crippling incapacity. The possibility of providing the needed assistance is reduced. Procrastination is again the most common mistake. It can be explained but not justified. Measures have not been employed so as to offer a reasonable certainty of benefit without imposing unreasonable hazards. Patients are subjected to operation who are beyond help in the hope of some miraculous achievement.

Thoracoplastic operations are performed to immobilize and compress lung and thus to "cure" tuberculosis. Operators argue as to whether the upper or lower ribs should be resected first, how small a segment of rib it is necessary to excise, whether a given number of centimetres of eleven ribs should be removed in one or more stages, and whether the anæsthetic should be local, general, or combined. The nature, extent, and location of lesions and the propriety of preserving the function of uninvolved lung apparently do not enter into calculation. Internists are relied upon to decide which patients are suited for operation and which are not. Inability to improve under pacifistic measures demonstrated by having observed continued progress of the disease over considerable periods is the one accepted indication for operation. Preparation of patients so as to reduce risks and to limit the extent of operation is given scant, if any, consideration. Proof of the superiority of measures advocated is submitted in the form of statistics. Figures are given that show the percentages of those that are "cured," improved, unimproved, and succumbed, but no mention is made of the basic factors, the capacity of patients to make, to deliver, and to aërate blood before, during and after operation.

Operations can but aid in improving the quality of blood, in increasing the unit volume of blood delivered to the affected lung, in reducing cardiac labor, in restricting the excursions of diseased lung, in altering intrathoracic tension so as to facilitate healing, and in eliminating irreparably diseased tissue. These adjuncts in treatment will be the more efficacious the earlier they are employed if they be employed in proper sequence, but they can be fully efficacious only if the other measures, *e.g.*, diet, amounts of rest and exercise, fresh air and sunshine, are suitable. Surgeons are held entirely responsible for the recovery of patients whatever be their condition when referred for operation. Surgeons have the right to insist that non-operative care be of the best before and after operation, that opportunities for operative assistance be offered to patients early, and that those subjected to operation be sufficiently robust not only to withstand the immediate stress but also later to profit by the intervention. They are obligated to devise and adapt operations that will promote the welfare of each individual and to deny possible benefits to none lest an unfavorable outcome impair the impressiveness of statistics. Clinicians, if there be reasonable doubt, cannot as yet determine whether or not usefulness of life may be increased and prolonged save by trying. Fatalities soon after operation need occur infrequently; indeed, life should

be lengthened so regularly that the benefits conferred can be measured by increment in usefulness.

III. How operations can be performed to (a) improve the quality of blood, (b) increase the quantity delivered to affected lung with least cardiac labor, (c) alter intrathoracic tension so as to retard absorption and promote healing, and (d) eliminate irreparable lesions without the addition of undue hazards.

(a) *Quality of Blood.*—In the early stages blood deficits are quite constant in the plasma, whereas the responses of the hæmatocyto blasts are usually favorable. If improvement is not prompt and progressive with rest, diet, fresh air, sunshine, and phrenemphraxis, transfusions of unmodified blood from donors known to be insusceptible should be employed. No other means are as certain. Should this assistance fail to produce improvement, the prognosis is quite hopeless.

The blood deficits in the later stages include both cellular and non-cellular constituents and are the early phases of cachexia. The quality can be often improved, and the volume in circulation can be raised by the intravenous administration of salt and glucose solutions before, during, and after operation, sometimes supplementary to transfusions, sometimes instead of them. Thus some patients can be prepared for operation who would otherwise be unable to withstand the added stress; some whose blood pressures waver during operation can be stabilized; and those whose pressures fall after operation can be resuscitated. Patients so assisted are not only enabled to survive operations, but also are the more certain to derive greater benefits from them.

The helpfulness of transfusions of unmodified blood, particularly when repeated, are unrecognized by those who have used improperly selected donors, have added anticoagulants to the blood, or have employed transfusions, usually singly, too late, or not at all.

Two dangers are avoidable. Too large amounts of blood or blood introduced too rapidly will cause acute dilatation of the right heart. If the blood is introduced too slowly, particularly in hot weather, clotting is likely. The embolism need not be immediate and can be fatal several days later. If there be doubt, the amount of blood that can be given safely may be determined before transfusion by testing tolerance with intravenous glucose injections. Patients, dehydrated and starved from gastro-intestinal malfunctions, especially by vomiting, are greatly benefited when given salt and glucose intravenously.

In order to determine what should be done to assist patients, it is only necessary to remember that serious blood deficits in cells or plasma preclude recovery and prohibit operation. Some may be corrected in one way, others in different ways. The basic facts are established. Patients' general condition and their lesions become more favorable as their blood improves. Conversely, if the healing of lesions is facilitated by operation, the blood and general health are bettered. In other words, some operations, *i.e.*, transfusions and intravenous injections, improve the blood directly. Other opera-

tions that retard absorption of noxious products by limiting pulmonary excursions or reduce the irritants disseminated by facilitating healing improve the blood indirectly because the blood-forming units are thereby relieved of slight but constant injuries.

(b) *Quantity of Blood*.—Restriction in parietal mobility and in the intrapleural negative pressure needed to diminish the volume of lung and to limit its excursions so that the delivery of blood shall be most advantageous for repair can be attained in accordance with natural responses by paralyzing the diaphragm. Paralysis of the diaphragm decreases vital capacity and restricts competence of the individual.

Blocking the nerve trunks conducting motor impulses to the diaphragm may be temporary or permanent. Temporary blocking is indicated as a part of treatment when the disease is incipient or moderately advanced as a means to check hemorrhages and as an introduction to more radical operations if later the recovery of function of the diaphragm will be advantageous. Permanent blocking is expedient in some of the few patients whose diaphragms cannot be paralyzed by measures that produce temporary blocking, in the patients whose improvement ceases as the diaphragm is reactivated following temporary blocking, when healing of existing lesions would impose handicaps as great or greater than diaphragmatic paralysis, and as a preparation for extensive costectomies.

A diaphragm can be paralyzed for from two to four months by crushing the branches of the phrenic nerve more or less severely.<sup>6</sup> Adequate exposure is attained through a transverse incision, one and a half inches long, extending mesially from the outer margin of the sternomastoid muscle in a skin crease just above the clavicle. Fibres of the sternomastoid are separated in the outer third of the muscle and retracted. The deep fascia is divided along the lower border of the omohyoid, and this muscle is dislocated laterally. Sometimes the scalenus anticus lies lateral to the deep jugular vein, and this vessel need not be disturbed. Sometimes the scalenus anticus lies behind the vein which is loosened along its lateral margin and retracted mesially. The fat overlying the scalenus anticus is separated mainly by blunt dissection so as to avoid injuring the transverse cervical artery. Retraction of this fat permits search for the phrenic nerve trunks. They are fused in one bundle in about three out of five persons, which lies on the anterior surface of the scalenus anticus in accordance with the classical description. There may be two or three branches similarly placed or the branch or branches may lie along or even behind the lateral or mesial border of the muscle. Rarely one or more branches perforate the sternomastoid. Not infrequently accessory branches

<sup>6</sup> Transient paralysis of the diaphragm, lasting three or four days, can be caused by injecting the motor branches of the phrenic with 1 per cent. cocaine. This is useful before thoracotomy and to relieve exceptionally severe hiccoughing. Paralysis of longer duration can be provoked with the injection of alcohol of appropriate strength, but is too dangerous. Not only is wound healing impaired, but there is also likelihood of provoking an intense neuritis in the trunks of the brachial plexus.

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accompany the nerve to the subclavius muscle, descend into the chest lateral to the usual course of the phrenic, and join the main trunk of the phrenic at a lower level. Accessory branches arise from the lower three cervical and first thoracic nerves and by exception from the twelfth cranial. Exceptionally the diaphragm receives considerable motor innervation from the twelfth thoracic nerve.

When the phrenic consists of one trunk it contains both motor and sensory branches. When there is more than one trunk, though motor and sensory branches are usually mixed, they may be separated. Consequently, any one branch may be transmitting only motor or only sensory impulses or mainly motor or mainly sensory impulses.

Paralysis of the diaphragm produced by nerve blocking or phrenemphraxis is most effective when complete, and when complete a paradox appears; the paralyzed side ascends during inspiration. The simplest way to determine when relaxation is attained is to perform operations with the patient upon a fluoroscopic table. The motion of the diaphragm is observed; then the phrenic nerve is exposed. If one large trunk is encountered, it is held gently in a clamp; the fluoroscope is used; and the clamp is closed abruptly. A sudden contraction of the diaphragm occurs. If all the motor nerves have been blocked, motion ceases; the diaphragm rises, and a paradox appears at once or after some hours. Otherwise, following the first contraction, there is incomplete relaxation, and some contraction occurs with deep inspiration. It is then necessary to discover accessory branches, to repeat fluoroscopic observations, and so continue until immobilization is attained. In ten patients out of twenty-five the main trunk, when found, is smaller than usual. Accessory branches are sought, first lateral, then mesial to the scalenus anticus. Crushing and fluoroscopy are continued until immobilization is produced. Careful dissection and a little experience make it possible to succeed in causing a transient paralysis in all but a few patients, possibly two per cent.

Permanent paralysis can be induced by extensive crushing of phrenic nerve trunks, by resecting portions of the trunks (phrenisectomy) and by dividing the main trunk and extracting the distal portion from the chest (exeresis).

Exeresis is the method of choice. It is only necessary to locate the main branch of the phrenic as its withdrawal will tear out accessory branches. Failure to cause complete paralysis is very rare and occurs when the diaphragm receives a considerable part of its motor innervation from the twelfth thoracic nerve or possibly if an accessory branch fails to fuse with the main trunk of the phrenic. It is unwise to use much force in extraction because of the danger of disrupting adhesions and provoking hemorrhage. Under such conditions extraction is carried to the limit of safety and the trunk excised at its lower level of exposure. This is the one indication for phrenisectomy. During extraction of the distal segment of the nerve the thoracic duct may be torn close to its termination. Patients to be subjected

to exeresis on the left side should drink milk slowly before operation. Then laceration of the duct cannot be overlooked and the leaking duct is easily found and ligated, a harmless procedure. Phrenicotomy and severe and extensive crushing of the phrenic nerve are not employed because they do not assure permanence of paralysis. All operations on the phrenic nerve are performed under local anæsthesia.

(c) *Alteration of Intrathoracic Tension.*—The first step is to induce temporary or permanent paralysis of the diaphragm and then wait a reasonable time to determine whether further intervention is necessary and to permit the intrapulmonary circulation to become readjusted. Patients needing additional assistance are of two types, those having rather diffuse involvement of the lung and those with the main lesions in the upper lobes. There is quite certain to be adhesive pleuritis over the involved lung so that the greatest effects of costectomy will be within subjacent lung. When the involvement is so general that collapse of the entire lung seems to be required, removal of ribs may well begin below. Delorme showed that the effects of rib resection were largest if the resection extended from behind the angle posteriorly and was carried forward to include the costal cartilages. We believe it expedient to follow Delorme's advice. An incision is made along the lateral margin of the erector spinæ muscles from the seventh rib to the eleventh and extended forward along the eleventh interspace. The twelfth and eleventh ribs are removed entirely and as much of the tenth, ninth, and eighth as can be reached, seldom more unless the patient's condition is unusually good. It is always safer to do just too little at any stage. The next step is to make an incision over the costal cartilages and to remove the parts of the ribs left at the first session and the costal cartilages from the tenth upward. When feasible the costal margin is exposed; the diaphragm, parietal pleura, and pericardium are pushed backward with blunt dissection. Then, instead of subperiosteal and subperichondrial resection, cartilages, ribs, and intercostal muscles are removed even back to include the field of original operation. The alteration of intrathoracic tension is as great as can be produced; regeneration of ribs and cartilages is prevented; the operation is easier and shorter; the distress is no more. Should additional resections be needed, they follow in alternating stages, back and front, until all excisable ribs and cartilages have been removed. Intervals between operations should be no longer than necessary for recuperation and to determine if further intervention is indicated. Some patients regenerate bone so promptly that if there be avoidable delay, the new bone nullifies the effects of previous and subsequent operations.

Resection of ribs begins above when the lesions are in the upper lobe. The object is to provide the relaxation needed to permit these lesions, which include numerous cavities, to heal. Wide resections are indicated but limited to the immediately overlying and subjacent ribs so as to preserve the function of the lower lobes. If the alteration of tension thus provided is insufficient to promote healing, a serious problem arises.



(d) *Elimination of Irreparable Lesions without Undue Hazards.*—Is it wiser to continue to resect ribs and inactivate good lung or should the lesions in the upper lobe be destroyed with a cautery as employed by Graham? Wide resection has been efficacious, but the reduction in vital capacity is too great. If partial and complete lobectomy with cautery is feasible, we believe that destruction is the better method. No patient has been willing to submit to this operation.

Anæsthesia is suited to the patient and to the operation. No one method can be employed as a routine. Nitrous oxide and ethylene are preferable to ether. Local anæsthesia is often imperative. Combined local and general anæsthesia has disadvantages that almost balance its manifest advantages.

Removal of pleuritic effusions and pneumothorax is desirable as a rule and frequently imperative. Tuberculous effusions can be removed advantageously, as Bowditch showed in 1850, by repeated aspirations. It is now possible to employ continuous one-way drainage. Harm occurs when the removal is too rapid or when the entrance of air is not prevented. The pleural surfaces are gradually reapposed, become adherent, and further effusion is impossible. If the lung cannot be reinflated, the parietal pleura is to be depressed to the visceral by appropriate costectomies in conjunction with aspiration or drainage. Air in the pleural cavity should be aspirated gradually unless immediate withdrawal be necessary to save life. If the diaphragm continues to move after the effusion or the pneumothorax develops, phrenemphraxis should be employed as well as aspiration.

Observations of the effects of operations upon patients at the Muirdale Sanitarium and Columbia Hospital since the measures described have been employed will be summarized to illustrate both advantages and disadvantages.

*Transfusions.*—Vincent paraffined tubes have been used. Robust donors are selected who are over thirty years old or who have recently recovered from active tuberculosis. The latter are preferable. Grouping and cross-checking of the bloods of donors and recipients are carefully done. Repeated transfusions of patients whose capacity to make blood is dissipated have given only transient benefits. Patients still able to make blood have shown progressive improvement after transfusion. A few, apparently hopeless, have been enabled to withstand operations that seem to have introduced recovery. One man, exsanguinated from repeated hemorrhages, was resuscitated with transfusion, and his bleeding ceased after phrenemphraxis. One woman was resuscitated after operation when death was imminent. She developed acute pneumonia later in the sound lung and another transfusion was followed with a rapid convalescence. Acute cardiac dilatation was caused in one man but did not prove fatal. One woman who was failing rapidly improved remarkably following three transfusions. On the fourth day after the last transfusion she suddenly became cyanotic and dyspnœic. She lived four days. Necropsy disclosed an embolus almost completely plugging the pulmonary artery in her sound lung. Glucose and salt in hypertonic solutions have proved their value and should have been used more often.



## OPERATIONS IN PLEUROPULMONARY TUBERCULOSIS

*Paralysis of the Diaphragm.*—Temporary blocking has been induced ninety times in patients whose disease is classified as incipient, moderately advanced, and advanced. Alcohol, 60 per cent., was injected in three. Crushing was used in the others. The transverse cervical artery was torn in one; the subclavian vein was lacerated in one; both recovered. One patient developed a spontaneous pneumothorax on the opposite side and died because a diagnosis was not made. This occurred before the present staff was appointed. One man has since developed a pneumothorax following costectomy. It was recognized promptly and relieved by aspiration. No other complication has been encountered. It was difficult at first to gauge the amount of crushing required. The paralysis is permanent in three patients and has been too brief in a few others. Recent results seem to be dependable. Operative and post-operative discomforts are slight; healing is smooth; scars are not prominent; and there is no deformity.

Permanent paralysis has been induced forty-two times; exeresis thirty-one, and phrenisectomy eleven. Once exeresis failed to produce paralysis. Twice the thoracic duct was lacerated and ligated at once without noticeable effect. The disease of all patients was advanced.

An exact estimate of the effects of induced paralysis of the diaphragm is impossible because it was only a *part* of treatment. Except the one patient sacrificed by failure to recognize pneumothorax, none was injured. Some received no benefit. Some improved after operation who had failed to improve before and the treatment was otherwise the same over a period of years. Some improved until the diaphragm regained its activity and then began to fail, thus proving that paralysis had been beneficial. A few patients in whom paralysis was induced preparatory to costectomy proceeded toward recovery without further intervention. In others the preliminary paralysis was a factor in limiting the number of ribs it was necessary to resect. Preliminary paralysis appeared to reduce the hazards of subsequent thoracoplasty. Induced palsy alone or with transfusion has stopped hemorrhage from pulmonary and bronchial arteries and does not predispose to hemorrhage although one patient died of hemorrhage subsequent to phrenemphraxis. Paralysis of the diaphragm is as effective or more effective than induced pneumothorax and is applicable when there are pleural adhesions. It imitates natural defence responses and does not add one morbid state to help another. No refilling is necessary. The total discomforts are less.

We believe phrenemphraxis is warranted as soon as a diagnosis is established. The diaphragm will be functioning again by the time an incipient lesion can be healed and the patient's general health is stabilized. It will hasten as well as facilitate recovery. Temporary or permanent paralysis should be induced in all but the fatally affected patients in whom the disease has passed the incipient stage, as it promotes repair, obviates the need for further intervention, or reduces the extent and risks of more radical operations if they are required. It is a dependable means to control hemorrhage and to reduce pain.

Twelve patients have been subjected to twenty-nine rib resections that removed more or less completely four to twelve ribs. All were prepared with preliminary paralysis of the diaphragm, some with transfusions. None has died. Two were benefited but temporarily. Two are apparently healed, and their blood is normal. The others are improving and may require no further operation.

Radical resection of ribs, perhaps including the intercostal muscles, can be done virtually without danger if the operations are adapted to the requirements of individuals who have been suitably prepared and procrastination is eliminated. Many patients thus assisted who would otherwise be confined to sanatoria will be enabled to recover sufficiently to lead useful and productive lives without endangering or annoying their associates.

#### CONCLUSIONS

Improvement of methods of treatment is needed if each patient is to be given full opportunities for undelayed recovery from pleuropulmonary tuberculosis or for prompt arrest or retardation of the progress of the disease.

The basic obligation of treatment, which is to promote healing of pleuropulmonary lesions with the least cicatrization, is attainable by improving the quality and increasing the quantity of blood delivered to affected lungs and restricting their excursions, by altering intrathoracic tension, and by destroying irreparably diseased structures.

This obligation can be fulfilled whether the disease be incipient or advanced by combining non-operative measures (rest, diet, fresh air, sunshine, and drugs) with operative measures (transfusions of unmodified blood, intravenous administration of salt and glucose solutions, induced palsy of the diaphragm, resection of parietes, and partial or complete lobectomy with cautery).

Operative adjuncts to the non-operative methods of treatment, applicable whether the disease be incipient or in more advanced phases, are not only available, but also will fulfill therapeutic requirements if utilized in proper sequence, without adding hazards save the infrequent accidents of minor surgery.

Progressive improvement in the treatment of pleuropulmonary tuberculosis is assured and will be the more rapid if the non-operative and operative measures now in use are modified and new measures are developed so as to coöperate even more effectively with the natural responses which provide resistance, defense, and repair.

# THE TREATMENT OF SUCH CASES OF CHRONIC SUPPURATIVE BRONCHIECTASIS AS ARE LIMITED TO ONE LOBE OF THE LUNG\*

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THE term suppurative bronchiectasis, at the present time, is used rather loosely to include not only true suppurative bronchiectasis in which the disease is limited to the bronchial tree, but also those conditions in which there is a varying amount of infection in the parenchyma of the lung, associated with dilatations of that part of the bronchial tree. This latter pathology, we believe to be much more common than the former in which the disease exists only in the bronchial tree. The amount of infection in the lobe may vary from a comparatively small area about the branches of the bronchus to one that includes the entire lobe. Probably a more correct term is chronic bronchopulmonary infection with bronchial dilatations.

It seems to the Thoracic Clinic at the Massachusetts General Hospital, that all methods of treating this disease other than its radical removal by some surgical procedure, are merely palliative and will not cure this condition, with possibly extraordinarily rare exceptions.

Medical treatment may be dismissed by saying that it will never cure this condition, although if the patient can devote his days to taking care of his health, spending his winters in a warm dry climate, and using postural drainage, it may be that he will live a long and fairly comfortable life.

Bronchoscopy will not cure this disease, but if the patient is willing to be bronchoscoped at regular intervals, there is no question but what his condition will be improved, in that the septic symptoms will largely subside and the amount of sputum raised will be diminished. It seems to us that the greatest benefit from bronchoscopy is obtained from aspiration of the pus from the bronchial tree, by the dilatation of any stricture or strictures of the bronchus and by the removal of any granulation tissue that is tending to obstruct the bronchus. We do not feel that irrigation of the bronchial tree or the injection of medicated oils is of any therapeutic value. The early cases of bronchiectasis which are caused by the lodgement of a foreign body in a bronchus and which are promptly cured by its removal, are not included in this discussion.

A third possible method of treatment is artificial pneumothorax. Here, again, we do not believe that any cure can be brought about by its use, with possibly very rare exceptions. On the other hand, if the lung is not adherent to the costal pleura, so that it can be completely collapsed, the general condition of the patient will be improved and the amount of sputum will be much diminished. But when the lung is allowed to expand, the symptoms

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gradually return and it is found that the disease has not been cured. In many instances in which artificial pneumothorax is kept up for a long time, fluid will appear in the pleural cavity, which will cause this form of treatment to be abandoned, and it is not uncommon for this fluid to become infected, or, as in our experience in a few cases, during the treatment adhesions have been torn, opening the infected area in the lung, resulting in a virulent empyema. The condition then becomes more serious, as to the bronchiectasis there is added an acute empyema.

In an extensive research of the literature for the last twenty-four years, the impression is gained that there have been many failures, many partial improvements and there is an absence of any considerable number of actual cures. Those that are reported cured seem to us to fall more into the classification of lung abscess than into that of bronchiectasis.

Surgical operations for this condition are two-fold. The palliative ones by which no absolute cure should be expected (except possibly in extremely rare instances) and the radical ones by which a cure may be expected in a large percentage of the cases that survive the procedure.

There is no reason to suppose that drainage of the diseased area will produce a cure. However, it is quite justifiable to drain a large dilatation of a bronchus or a large abscess of the lung for temporary relief. This operation merely changes the direction of the drainage, and where the patient has been raising quantities of pus by coughing, following the operation large quantities come through the drainage tube and will continue to do so as long as there is an open sinus.

There is a certain amount of difference of opinion as to the value of graded thoracoplasty. When the disease is situated in more than one lobe of the lung, it seems to be the best operative procedure. But in dealing with the disease where it is limited to one lobe, our experience has led us to believe that it should be undertaken merely as a palliative. The general condition, following this operation, may be much improved and the amount of sputum temporarily or permanently greatly reduced, but it does not entirely disappear and the patient is not absolutely cured.

It would be a presumption for me to discuss Graham's cautery lobectomy, as our experience with this has been a very limited one. But in certain instances, when a limited amount of lung tissue is to be removed, as in cases of chronic abscess of the lung, situated near the periphery, which, although they have been drained, show little if any signs of being cured and have small hemorrhages, it seems to us to be the ideal procedure.

Amputation of a lobe of the lung inside the pleural cavity has been accompanied by a very high mortality. In fact the mortality has been so high in our hands at the Massachusetts General Hospital that the operation has been abandoned for the present, at least. Out of 6 cases operated upon, only 1 left the hospital alive. Some of the deaths were caused by unexpected accidents, as, for example, a sudden fatal secondary hemorrhage on the sixteenth day after the operation, and the development of a brain abscess in another

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case six weeks following operation when the side operated upon had done very well and after the patient had reached the stage of being up in a wheel-chair.

About a year and a half ago it occurred to us that it might be possible to do a lobectomy in an entirely different way, and the technic about to be described was employed in 5 cases, in all of which the disease was situated in a lower lobe. Under gas-oxygen and ethylene anæsthesia the pleural cavity is opened and the diseased lobe of the lung examined to determine the extent of the process and also the amount of adhesions about the lobe. This seems to us important, as, if the adhesions are very firm and extensive, it may be unwise to attempt a lobectomy. But if lobectomy is decided upon, sections of enough ribs are removed so that the diseased part of the lobe may be delivered from the pleural cavity after adhesions and the pulmonary ligament are divided. The lung is firmly sutured to the muscles of the chest wall by chromic catgut and heavy linen thread, taking very deep stitches into the lung tissue. One large gauze sponge is placed beneath the lobe to aid in holding it, and a No. 20 French catheter is placed to the root of the lung, kept shut off, and the wound closed as tightly as possible. By means of this catheter the large quantity of bloody serum that collects in the pleural cavity for a few days may be removed without allowing air to enter. Needless to say, when the operation is completed the amount of lung protruding from the wound seems small, it being possibly as large as an orange, but there is a good deal more lung tissue outside the pleural cavity that is hidden by the thickness of the chest wall. After this operation there has been surprisingly little shock and the picture is entirely different from that following the usual procedure, as we have seen it. Nature may then be allowed to complete the operation, as in about ten days the lobe has become necrotic. A dry gangrene is at first established, then gradually there is a profuse foul discharge and eventually, in about four to five weeks, this whole area sloughs off, leaving a clean healthy granulating stump deep in the pleural cavity with bronchial fistulæ in it. During this process of sloughing and discharging, the cough gradually diminishes to finally cease in the successful cases. The wound is lightly packed with gauze each day until it closes, which in the 2 completely cured cases took roughly three to four months from the time of operation. It was unnecessary for the patients to remain in the hospital for more than six to eight weeks. In the 2 cases that made complete recoveries, the bronchial fistulæ gradually closed without anything being done to them.

In one case of upper lobe disease, not included in this series, in which the operation was attempted, after the adhesions had been divided, the lobe was so small that it could not be delivered.

It may be that preceding this procedure a preliminary graded thoracoplasty should be done. Our reasons for not doing this were the fear that it might cause the formation of such firm adhesions that it would be impossible to free the lobe and also that the pressure on the lobe would cause it to become so small that it could not be delivered. We believe that whatever vital

capacity exists in the diseased lobe is promptly cut off by the operation, and that there is no danger of mediastinal fluttering in doing the operation in one stage. The empty space in the pleural cavity is, we think, gradually obliterated by the ascent of the diaphragm, the inflation of the upper lobe and the collapsing of the chest wall.

Apropos of this procedure, it was interesting to find in Stephen Paget's *Surgery of the Chest*, published in 1896, a report of 2 cases of hernia of a lobe of the lung following penetrating wounds of the chest wall in which there was no attempt to replace the lobe. The first case quoted by Paget was reported in 1499 by Rolandus and briefly is as follows:

"Called to a citizen of Bologna on the sixth day after his wound, I found a portion of the lung issuing between two ribs; the afflux of the spirits and the humors had determined such a swelling of the part that it was not possible to reduce it. The compression exercised by the ribs retained its nutriment from it, and it was so mortified that worms had developed in it. The most skilful chirurgeons of Bologna, judging death to be inevitable, had abandoned him. But I, yielding to his prayers and those of his parents and friends, made an incision through the skin, the breadth of my little finger-nail away from the wound, all round it. Then, with a cutting instrument I removed all the portion of the lung level with the incision. By the grace of God the wound cicatrized and recovery took place."

Paget also quotes a case of Tulpius in 1674 of "A man who while drunk received a penetrating wound below the left nipple, but was too drunk to heed it. The next day he found a protruding portion of the lung of three fingers' breadth. He now took a two days' journey to Amsterdam with the lung still hanging out unheeded and undressed. Tulpius ligatured it and cut it off with scissors. The patient healed quickly and had no further trouble save a cough at times."

It would seem from a comparison of these 2 cases with the 5 reported here, that we have unwittingly come upon a simple technic employed by nature four hundred years ago.

Of the 5 cases (full details of which will be published with this paper), No. I, a boy, aged eighteen years, and No. III, a man, aged forty-eight years, made complete recoveries, in that they are entirely healed, have no cough or sputum and have returned to their normal occupations. Case I left the hospital at the end of eight weeks and was entirely healed three months after operation. Case III stayed in the hospital six weeks and was entirely healed three and a half months after operation. Case II, a boy, aged nineteen years, has improved, as the cough and sputum are much less than before operation, he still has a small thoracic fistula, after a period of a year and three months, but has been well enough this winter to drive a truck every day. In Case IV, a boy, aged nine years, the side operated upon did as well as the others had done, but he died on the tenth day following operation, having developed pneumonia on the other side. Case V, a man, aged twenty-three years, was operated upon only six weeks ago and is making a very good convalescence.

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It is well realized that it would be absurd to draw any conclusions from these 5 cases, but it seems fair to make the following statements:

1. That it is possible to perform a lobectomy by this method.
2. That in our hands this operation has been followed by less shock than any other technic.
3. That 2 of the 5 cases have been cured and have returned to their normal occupations.
4. That the operative procedure can be completed in one stage without excessive risk.

CASE I.—A. P. D., Massachusetts General Hospital, 272,322. A boy, aged eighteen years, entered the hospital, October 1, 1925. His chief complaint was that he raised a large amount of foul sputum each day.

*Present Illness.*—Two years previous to entering the hospital, without any known preceding illness, the patient began to cough and raise sputum which soon acquired a foul odor and nauseating taste. The cough and sputum raised gradually increased in severity and in amount, until for the past six months he has been having three or four paroxysms of coughing each twenty-four hours, during which he raises about a pint of foul purulent sputum. Has lost no weight and has no other complaint or symptoms. Family history and past history irrelevant.

*Physical examination* shows a well-developed boy, but somewhat thin. His general appearance, however, is a fairly healthy one. There is considerable clubbing of fingers and toes. In the left back there is some dulness and a few scattered râles; otherwise nothing abnormal found. Temperature varies from 97° to 99° F., pulse 70 to 80, respiration 20. Urine, negative. Examination of blood shows: White blood-cells, 12,000; red blood-cells, 5,000,000; hæmoglobin, 85 per cent. Sputum 10 to 12½ ounces daily, foul and green in color. Short chain streptococci, both intra- and extracellular. Occasional leptothrix. Many influence bacilli.

*Operation*, October 8, 1925, under gas-oxygen anæsthesia. A long section of the eighth rib removed. Pleural cavity opened, lower lobe explored and found to be adherent to the diaphragm and upper lobe. There was a thickened, hard, dark area occupying the lower third of the lobe. Long sections of sixth and seventh ribs excised. After the lobe had been freed from adhesions, it was brought out to the chest wall and sutured there (using the technic already described).

Good convalescence. Eight days after operation the necrotic part of lung burned off with actual cautery. Severe hemorrhage, but this was controlled by packing with gauze. The convalescence following this was very smooth and patient was discharged to Out-patient Department eight weeks after first operation. Wound gradually closed in and healed. On April 8, 1926, patient reported at Clinic entirely healed, no cough and able to resume his normal occupation.

CASE II.—J. J. D., Massachusetts General Hospital, 274,418. A boy, aged nineteen years, entered the hospital February 2, 1926. His chief complaint was that he had been coughing and raising foul sputum for eight months.

*Present Illness.*—One year ago the patient had influenza with pleurisy and was in bed six weeks. He made a complete recovery and returned to work. Eight months ago had a tonsillectomy performed under ether, which was followed almost immediately by a non-productive cough, and two weeks later had a foul breath and began to raise foul-smelling and tasting sputum. Six months ago began having paroxysms of coughing, during which he raised large amounts of purulent sputum. For many weeks has had two to three chills and night sweats per week. Has lost 12 pounds in weight, but feels well and vigorous except for coughing. Family history and past history irrelevant.

*Physical examination* shows a well-developed and nourished boy. Right chest is



diminished in size and excursion. There is increased fremitus, decreased breath sounds and slight dulness over the right lower back. Some râles are heard at the apex. There is slight clubbing of fingers and toes. Temperature varies from 97° to 97.5° F., pulse 70 to 90, respirations 20 to 25, urine negative. Examination of blood shows: White blood-cells, 13,800; red blood-cells, 4,600,000; hæmoglobin, 75 per cent. Sputum 3 to 7 ounces daily, occasionally blood-tinged and foul. Examination shows pneumococci, streptococci, staphylococci, influenza bacilli, no tubercle bacilli.

*Operation* February 8, 1926. Gas and oxygen anæsthesia. A long section of seventh rib removed. Pleural cavity opened. Examination of lower lobe showed it to be adherent to diaphragm and there was a large, hard, dark area in it about as large as a lemon. Long sections of sixth and eighth ribs removed. Lower lobe freed from adhesions and brought out to the chest wall and sutured there.

Convalescence good. Discharged to out-patient department six weeks after operation, with a persistent sinus and bronchial fistulæ and some cough and expectoration.

Patient was last seen on November 16, 1926. At this time his general condition was good, but he still had a small thoracic fistula. Patient stated that whenever he caught cold, he coughed and raised some purulent sputum, but that when he did not have a cold, there was very little sputum and very little discharge from the fistula.

**CASE III.**—A. A. V., Phillips House, Massachusetts General Hospital, April 16, 1926. A man, aged forty-eight years. A year and five months previous to entering the hospital had all his teeth extracted under ether. He states that in about ten days he began to have a cough and pain in the left lower part of chest. Soon after this began raising considerable foul-tasting sputum. Has been unable to do any work and has devoted himself to trying to regain his health by rest and medical treatment. He states that his cough is worse at night than in the daytime and that during each twenty-four hours he raises nearly a pint of pus, which at times is very foul smelling.

*Physical Examination.*—Thick-set man, prominent abdomen, short neck, muscles well developed. Nothing abnormal found in heart or right lung and the only changes from normal in the left lung are occasional râles and dulness below the angle of the scapula. Temperature normal, pulse 70 to 80.

Examination of sputum shows many leucocytes and occasional squamous cells, a few blood-cells, no tubercle bacilli, many influenza bacilli, and pneumococci, streptococci and staphylococci, also some large bacilli.

X-ray examination shows a definite process in the left lower lobe, which involves the bronchi and peribronchial tissues. The lower portion of the shadow is quite mottled and is suggestive of several cavities, but there are no fluid levels to be demonstrated.

Patient returned to his home for about three weeks, in order to attend to some business matters and then returned for bronchoscopic examination, which showed a large amount of pus coming from the left lower lobe bronchus. This was injected with lipiodol and X-ray taken following this, showed several dense shadows in the left lower lobe, which were interpreted to be several abscess cavities, some being larger than others.

*Operation*, June 3. Started under local anæsthesia and completed under gas and oxygen. Sections of the ninth and tenth ribs were removed, the pleural cavity opened and the lower lobe of lung explored. At one small area this was adherent to the costal pleura, but otherwise was free from adhesions. A hard, firm area, about the size of a lemon, occupying the lower part of the lobe, was easily palpated.

Section of the eighth rib was then removed and the diseased part of the lung delivered onto the chest wall and sutured there. Gauze was placed around this part of the lung and a catheter placed in pleural cavity. The wound was then closed as tightly as possible.

The patient was returned to bed in excellent condition. For two days large amount of bloody serum was aspirated from the catheter at frequent intervals. For two days temperature rose each afternoon to 100° F., but after this did not go above 99° during his entire convalescence. At the end of two weeks the lung had become necrotic and



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was slowly sloughing away. The patient's cough was gradually improving and the amount of sputum diminishing. At the end of four weeks the lung had sloughed off, leaving a healthy granulating stump and the cough had entirely disappeared. At the end of six weeks, the patient was discharged from the hospital with a wound that was rapidly filling in and required only one gauze sponge for packing. He returned to his home in the western part of the state of Massachusetts and was there taken care of by his local physician. He returned to me on October 17, 1926, at which time his wound was entirely healed, he had no cough, felt very well and his only complaint was some numbness along the costal margin. He has since returned to his normal occupation.

CASE IV.—R. B., Massachusetts General Hospital, 278,053. A boy, aged nine years, entered the hospital, August 12, 1926. His chief complaint was cough with abundant purulent sputum.

*Present Illness.*—Ten months ago aspirated a pistachio nut. A week later had high fever, cough and chills, and was in bed for six weeks. The acute symptoms subsided, and were followed by chronic cough, foul breath and foul purulent sputum. He was said to have had "pneumonia" two months ago followed by exacerbation of symptoms. He has had severe paroxysms of coughing with evacuation of large quantities of pus, and then fall in temperature. The sputum has been occasionally blood-streaked. He has lost 5 pounds in year. The family history and past history irrelevant.

*Physical Examination.*—Thin, poorly nourished boy. Skin dry. Left chest diminished in size and excursion. In the left back below the angle of the scapular, there is dulness and increased fremitus. Many râles are heard on this side and a few posteriorly on the other side. Temperature varies from normal to  $101^{\circ}$ , occasionally up to  $105^{\circ}$  F. Pulse, 90 to 150. Respirations, 20 to 50. Urine negative. Examination of blood shows: White blood-cells, 9700 to 15,000; red blood-cells, 4,500,000; hæmoglobin, 75 per cent. Smear, moderate achromia. Wassermann, negative. Sputum, 1 to 4 ounces daily. Many pneumonia streptococci, influenza bacilli, and no tubercle bacilli. Bronchoscopy showed left primary bronchus filled with muco-pus, which was aspirated and an apparent abscess cavity observed. Lipiodol injected.

*Operation*, October 1, 1926, under ethylene. Long sections of the fifth, sixth and eighth ribs were removed. The lower lobe was thick, hard and contained many small abscesses. The lobe was mobilized and brought out on to chest wall and sutured there. Transfused after operation. His condition was fair. On the third day after operation signs of pneumonia developed in right mid-chest. On the seventh day he was transfused again. There were definite signs of pneumonia in the right side. The patient died on the tenth day following operation.

CASE V.—N. P., a young man, aged twenty-three years, entered the Massachusetts General Hospital, March 29, 1927. His chief complaint was cough with abundant very foul sputum.

*Present Illness.*—Four years ago he had a right-sided pneumonia followed by empyema, which was operated on twice by rib resection in a hospital in another city. Drainage was kept up for five months, when the wound closed. Soon after this he began to cough and raise pus. Two years ago he worked for eight months, but as his cough and sputum gradually increased, he gave up his work. In February, 1927, went to a sanitarium where no tubercle bacilli or other evidence of tuberculosis was found. Patient states that for several months before entering the hospital, he was raising about two cups of very foul-smelling pus each twenty-four hours, which had never contained any blood.

*Physical Examination.*—Well-developed and nourished man, but rather pale, with marked clubbing of the fingers and toes. The sinuses not remarkable. There is a perforation of the nasal septum. The record states: "Horrible breath that announces his presence." There is dulness in the right lower back, with diminished breath sounds and diminished tactile fremitus. There are a few râles in this region, otherwise the lungs are negative and the heart is negative.

*X-ray Summary.*—Old thoracotomy wounds in ribs of lower right chest. The findings are those of a pathological process in the right lower lobe, and multiple areas of diminished density, which suggest cavitation and incomplete expansion of the lung. Appearance suggests bronchiectasis, otherwise the lungs are clear.

The urine is negative. Blood examination shows white blood-cells 16,000, red blood-cells 3,500,000, hæmoglobin 55 per cent, blood-pressure 110/80.

*Operation,* April 8, 1927, under ethylene and gas oxygen. Sections of seventh, eighth and ninth ribs were removed. Very firm adhesions were found between the lung and pleura. The pleura was found considerably thickened. The lower lobe was found to be small and hard; it was freed from adhesions to the pleura, upper lobe and mediastinum. Deep stitches with chromic catgut were taken close to the root of the lung and gently tied; these were then brought out through the muscles and tied.

One large gauze was placed beneath the lung to the bottom of the pleural cavity. A No. 20 French catheter was placed to the root of the lung and three small gauzes also placed about the delivered portion of the lung. Wound closed as tightly as possible.

Following operation patient was transfused.

Good convalescence. For three and a half weeks his temperature ran daily up to 101 or 102° F. Troubled with hemorrhoids and irritated rectum with some diarrhœa. This gradually cleared up and temperature became normal at end of four weeks. At this time lobe had sloughed off leaving healthy stump in pleural cavity with fistulæ in it. There was very little cough and sputum. There is no odor to the breath or sputum and there has been none since one week after operation.

# SOME SURGICAL PROBLEMS ATTENDING THE OPERATION OF EXTRAPLEURAL THORACOPLASTY

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TO OBTAIN a cure in all cases of unilateral pulmonary tuberculosis the primary object, irrespective of the procedure used, is to put the diseased lung at rest. This physiological rest can only be accomplished by collapsing the organ. In 80 per cent. of one-sided tuberculous cases this collapse can be successfully accomplished by artificial pneumothorax. In the other 20 per cent. because of the adhesions between the parietal and visceral pleuræ complete collapse of the lung is prevented. It is in this 20 per cent. of cases that the so-called "Wilms-Sauerbruch" operation of paravertebral extrapleural thoracoplasty offers the only possibility of that collapse. In a study of our series of 91 operations of extrapleural thoracoplasties performed upon 51 patients during the last five years, we have been impressed by the fact that complete collapse has failed of accomplishment following the operation in 8 per cent. of the cases, this failure making necessary supplementary and different surgical procedures. Sauerbruch's observations parallel these of our own. He states that in 14 per cent. of his cases there was failure of collapse and the necessity of further surgery. We noted in 3 of the earlier thoracoplasty cases where we had failed to thoroughly and completely remove the ribs close to the vertebral transverse processes, after the new ribs had regenerated from the periosteum and had fused and immobilized the collapsed thoracic cage, in the costovertebral angle left between the rib stumps and the vertebra, there was a definite area of uncollapsed lung which persisted and which defeated the object of the primary operation. In these cases we were forced to do a third-stage operation, to reinvade the old operative field and with rongeurs removed the stumps of the ribs close to the spine, also enough of the regenerated ribs to permit of complete collapse of the hæmothorax and obliteration of the dangerous angle. Again in 4 cases after both stages of thoracoplasty operation had been done we found that apiceal cavities persisted despite the collapse of the thoracic cage. The fibrosis of the peripheral walls of the cavity held it patent, with resultant persistence of expectoration and the constant menace of extension of disease to the well lung. This is the type of case where the Touffier "apioclysis" procedure used to be exploited, where resection of the ribs in front and stripping of the parietal pleura from the chest wall was followed by transplantation of a pedicled muscle flap, a sterile gauze sponge, paraffin, or an autogenous transplant of fat. Whichever method was used the endeavor was to collapse the cavity walls. This pneumoclysis has a relatively high mortality and its employment has crystalized into its being used, according to Lilienthal, "where only the

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\* Read before the American Surgical Association, May 12, 1927.

compression of that part of the lung is desired" or where further surgery is contra-indicated. In our 3 cases we did a third-stage operation (parasternal) through an incision like the preliminary incision of Rodman's breast operation, removing the costal cartilages and several centimetres of the first, second, third and in one instance the fourth ribs. This procedure which following the two primary stage thoracoplasty operations gave excellent collapse of the thorax with ultimate collapse of the cavity. In one case we removed the anterior wall of the apical cavity with a cautery blade and then treated the cavity with mercurochrome-220, gentian violet and nitrate of silver. A tuberculous fistula has persisted for eighteen months, the cavity is still patent—we contemplate a complete thoracoplasty to collapse and obliterate it. Sauerbruch and his assistants have exploited phrenocotomies as a preliminary to extrapleural thoracoplasty, paralyzing one side of the diaphragm and thereby lessening the lung capacity by from one-sixth to one-third. He believes that this operation alone is indicated in certain cases and in others is an index to the patient's resistance to surgery. In the rare cases of unilateral basal tuberculosis or where the patient is too ill to accept the immediate hazard of the larger thoracic procedure, or where after complete thoracoplasty the base of the lung fails to completely collapse, we have done the operation of phrenocotomy or, in the later cases, that of exeresis of the phrenic nerve. This latter operation is indicated because in 20 to 30 per cent. of the cases there is an accessory phrenic nerve which after resection of the main trunk of the nerve still helps to enervate the diaphragm. Avulsion of the nerve avulses as well the accessory branches and assures certain paralysis of the hæmodiaphragm. Experience has shown that it is only necessary to avulse from 10 to 12 centimetres of the phrenic nerve to destroy all accessory branches, yet frequently 30 centimetres have been avulsed. After thoracoplasty and these accessory operations, X-ray studies of the collapsed lung have been made after instillation of lipiodol. These studies have borne out the clinical observations that the collapsed lung is at rest and non-functioning. The bronchi usually are shown as collapsed and few if any of the lung markings are visible. Occasionally the remains of collapsed cavities are shown or a bronchiectatic dilatation noted at the base of the collapsed lung. While these unfortunate tuberculous patients who come to operation of thoracoplasty or its supplementary surgery are bad operative risks and face a primary operative mortality of 1.5 per cent. and a secondary mortality, within six weeks, of 12 per cent., yet we must consider that most of them are doomed to a tubercular death without operative relief; as Alexander has shown from a study of 1159 operated cases in America and abroad that 36.8 per cent. are cured and 24.4 per cent. are decidedly improved. Surely if 61.2 per cent. of tuberculous patients can be saved to usefulness the operation needs no further argument. If the estimated 30,000 cases suitable for this operation in America alone were given the benefit of surgery and 18,360 helpless invalids were restored to health, no further brief is needed to justify this type of surgery.

## FURTHER EXPERIENCES WITH INTRA-THORACIC TUMORS\*

BY GEORGE J. HEUER, M.D.

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IN June, 1923, I presented before this Society my experience with eight cases of intra-thoracic tumor, which had been subjected to operation. These cases included a sarcoma of the rib, a benign calcified intra-pleural cyst, a benign xanthoma, a benign chondro-myxoma arising from the costo-vertebral articulation, an aneurism of the descending aorta, mistaken for a tumor, and three circumscribed endotheliomas of the pleura. It was an especially favorable group from a surgical viewpoint and a radical removal was attempted in each instance. In six of the eight cases a radical extirpation of the tumor was accomplished; in two (aneurism and pleural endothelioma) was deemed impossible. One patient died following operation. Of the five cases which recovered after a radical removal of the tumor, four were living at the time of the report; one, seven years, one, four years; and two, two years. One died ten months after operation presumably from a recurrence.

Since the time of that report, I have records of 25 additional cases, making my series up to the present time, 33. The 25 cases include:

(a) Two cases of sarcoma of the bony chest wall.

(b) Eight tumors of the mediastinum, *i.e.*:

One teratoma.

Two malignant tumors, probably sarcoma or thymoma, one associated with pernicious anæmia.

Two benign tumors, the diagnosis made on the long history and X-ray picture.

Two mediastinal Hodgkin's disease confirmed by biopsy.

One posterior mediastinal abscess mistaken for tumor.

(c) Three diffuse endotheliomas of the pleura.

(d) Nine tumors of the lung, *i.e.*:

Three primary carcinomas of the lung—one also called an endothelioma.

Four primary sarcomas of the lung—two also called endotheliomas.

Two metastatic tumors in which the pulmonary symptoms were predominant.

(e) Two so-called hour-glass tumors involving the spine and thorax; one a neurofibroma.

(f) One apical chest tumor diagnosed a myxo-sarcoma.

Of these 25 cases only nine were subjected to operation. The nine included one chest wall tumor, one teratoma of the mediastinum, one apical tumor, one posterior mediastinal abscess, one hour-glass tumor and four malignant tumors of the lung. The remainder were either obviously so

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\* Read before the American Surgical Association, May 12, 1927.

advanced that surgical treatment was contra-indicated or refused operation. Two of the most favorable cases in the series—the two cases of circumscribed benign lesion of the mediastinum, absolutely refused operation because of their general satisfactory condition. In a number of the advanced cases deep X-ray therapy was tried with brilliant, if temporary, results in the cases of Hodgkin's disease, but with little benefit in the remainder.

Of the nine cases subjected to operation, in only three was a radical extirpation of the tumor in the accepted sense of the term possible. These three cases include the mediastinal teratoma, the apical tumor and the hour-glass tumor of the cord. The case of posterior mediastinal abscess is not included. Of the three cases in which radical removal of the tumor was possible all recovered from the operation; two are well for from one to four or more years, while one—the apical tumor—had a recurrence within a year, and subsequently died.

To fully review this series of 25 cases would take me far beyond my time. I can only comment upon some of the interesting features of different groups of cases and then refer in more detail to the three cases in which radical extirpation was possible.

Perhaps the first comment one would make who has read the literature and whose own experience is gradually, if slowly, increasing, is the need of a clearer understanding of the pathology of intra-thoracic tumors. When one attempts to assemble the cases of any group of intra-thoracic tumors, he finds it almost impossible because of the varied terminology and the uncertainty as to the nature of the tumors. Whether one should call a given pleural tumor an endothelioma, a carcinoma or a sarcoma is just one example of a confusion which exists in many groups of intra-thoracic new growths. No one observer can do much to clarify the situation, for the number of cases he sees is too small; and it would seem necessary if we are to advance in the understanding of intra-thoracic new growths that the combined efforts of many be devoted to the subject. We ourselves have experienced great difficulties in classifying our tumors; for no two of our pathologists agree about many of them. As in other fields of surgery, we must begin with a pathological understanding before we can greatly advance in the diagnosis and treatment of these tumors.

Of the chest wall tumors, one illustrated a common mistake made here as in tumors elsewhere. A colored man was admitted with a swelling over the lateral thoracic wall attached to the ribs. He had a four plus Wassermann and was admitted with a diagnosis of a syphilitic lesion. Under anti-syphilitic treatment the swelling seemed to diminish and the pain decreased. In spite of this I advised operation, which was refused. Subsequently he developed a symmetrical lesion on the opposite side. While anti-syphilitic treatment was being given, both tumors softened and the original one became fluctuant. When the patient finally consented to operation, a radical operation was impossible; but a local excision of one of the tumors proved it to be a sarcoma.

Of the mediastinal lesions perhaps three deserve mention. One, a teratoma of the mediastinum to be more fully described later, presented the complication of a widespread infection with multiple abscesses in the tumor, with a discharging sinus in the neck communicating with an abscess in the teratoma and with a chronic empyema communicating externally by a drainage tract and internally with the growth. In spite of all these complications, the teratoma was removed, the chronic empyema cured, the sinus of the neck healed and the patient discharged well.

A second case presented the unusual association of mediastinal tumor and pernicious anæmia. The case was admitted to the medical service where a diagnosis of pernicious anæmia was made because of perfectly characteristic clinical and blood findings. She was transferred to our heliotherapy ward for the treatment of pernicious anæmia by radiation. Because of her thoracic symptoms X-rays of the chest were made and disclosed a mediastinal tumor which lay too far posteriorly perhaps for a thymoma. The association between mediastinal tumor, particularly thymoma, and leukæmia has been observed by Friedlander and Foot and Fabian, but in my search of the literature I have not found an association with pernicious anæmia. Unfortunately the nature of the mediastinal tumor is not known.

The third case proved at operation to be a posterior mediastinal abscess arising from a small tuberculous focus in the body of a vertebra. It is included because it illustrates another mistake we have made in diagnosis. In the series reported in 1923 we included a case of aneurism of the descending aortic arch which we explored under the mistaken diagnosis of tumor. The case of mediastinal abscess presented all the symptoms and signs of a mediastinal new growth: pain, dyspnœa, difficulty in swallowing, cyanosis, engorgement of the vessels of the upper thorax and neck and a circumscribed spherical shadow in the X-ray plate. There was no evidence of a spinal lesion in the X-ray and no evidence of tuberculosis elsewhere. We made a diagnosis of benign posterior mediastinal tumor and at operation found an abscess. The patient subsequently died of pneumonia.

The three diffuse endotheliomas of the pleura were characteristic of this condition. One presented an enlargement of the entire half of the thorax with bulging of the intercostal spaces. All had thoracic pain, severe dyspnœa, cyanosis and bloody effusion; and X-rays showed an enormous thickening of the pleura. Two cases had previously been drained in the hope of relieving the dyspnœa and a piece of thickened pleura removed for diagnosis. It is well known that aspiration of the fluid largely fails to relieve the dyspnœa in these cases; and this was well illustrated in our experience. Deep X-ray therapy had no effect upon the progress of the condition.

Of the seven patients with primary malignant tumors of the lung, four presented themselves with the symptoms and signs of empyema or lung abscess. Two had outspoken physical and X-ray signs of empyema and in each, aspiration of the thorax yielded pus. The possibility of a pulmonary tumor was suspected in one of the two cases, was unsuspected in the second.

At operation for empyema the tumor was discovered and a fragment removed in each instance. One patient died in the hospital without further treatment. The other recovered from his empyema and was subsequently operated upon for pulmonary tumor by Doctor Reid. As complete a removal of a squamous-cell carcinoma of the lung as was possible led to a marked improvement in the patient's condition and this together with X-ray and radium therapy gave the patient over two years of comfortable existence.

Two of the four cases gave the symptoms and physical signs of lung abscess and X-ray studies did not serve to differentiate this condition and tumor. Both were subjected to operation for presumed lung abscess. In one, the presence of a malignant tumor (sarcoma) was immediately evident and because of the vascularity of the tumor no attempt was made to drain the abscess. The symptoms of abscess, however, markedly improved and the patient was subsequently given X-ray therapy with considerable temporary benefit. In the other case an area of induration in the lung was penetrated and the abscess cavity opened and drained without finding anything to suggest a malignant tumor. Indeed sections taken from tissue forming the abscess wall showed nothing but chronic inflammatory tissue. The patient recovered and was discharged as a case of cured pulmonary abscess. About a year later he presented himself with sarcoma nodules scattered all over his body. While we have no autopsy record to prove it, it would seem that the pulmonary condition was a suppurating sarcoma.

The so-called hour-glass tumors form a very interesting group. Including our own case, there are but seven or eight described in the literature. But from conversations with neuro surgeons they must be more common than the number in the literature would indicate. Cushing has kindly sent me the abstract of one case and Elsberg tells me he has seen several. The characteristics of these tumors are that, arising within the spinal canal and causing compression symptoms with reference to the cord, they grow through an intervertebral foramen and extend into the mediastinum where they may enlarge sufficiently to cause thoracic symptoms; or arising within the mediastinum grow through an intervertebral foramen and secondarily compress the cord. In the majority of cases reported, the symptoms of cord compression have been predominant but more or less definite thoracic symptoms have led to an X-ray of the thorax and the discovery of the thoracic tumor in five of the seven cases reported. The surgical approach has been by laminectomy in five out of seven cases and the tumor followed into the thorax. In the case operated upon by me the intrathoracic portion of the tumor was small and was not discovered before operation. It was easily removed after the resection of portions of two ribs. The patient recovered and his cord symptoms entirely disappeared. He is well over four years. The second case presented the usual picture of a cord tumor and for a long time was treated on the orthopaedic service for paraplegia. When first seen by me the patient had definite thoracic symptoms and an X-ray showed a large intrathoracic tumor. Her general condition and the presence of pressure sores over her spine



precluded operation; and the diagnosis therefore is not verified. The cases of hour-glass tumor must be differentiated from primary intrathoracic tumors with metastases to the spine, a number of which have been reported in the literature; and in some of which the cord symptoms were the first and predominant symptoms.

Certain apical chest tumors form another interesting group. It is difficult to classify them otherwise than by their location; for they may pathologically be endotheliomas, sarcomas or other tumors; and may arise from the pleura, the subpleural tissues or the sheaths of the subclavian vessels. Clinically they may present the symptoms of pain in the shoulder, axilla and arm, muscular twitchings in the arm and hand, weakness and paralysis of the arm muscles and an associated sympathetic nerve disturbance indicated by ptosis, contracted pupil and enophthalmos. The condition was particularly emphasized by Pancoast of Philadelphia in 1924, who called attention to their similarity in symptoms to cord tumors. In two of the cases reported by him, a diagnosis of cord tumor was made and in one a laminectomy was done with negative findings. It is significant that pain in the shoulder, arm, or hand may be present for some time before the apical tumor is conspicuous in the X-ray plate and the correct diagnosis may be missed unless the condition is remembered. The case seen by me presented the usual symptoms of pain in the shoulder and arm but while evident ptosis was present, Horner's syndrome was not so evident as in some of the few other cases reported. The X-ray of the thorax showed a large tumor which was radically and apparently totally removed. The patient recovered but there was a rapid recurrence of the tumor from which he died. The three cases in which a radical removal of the tumor was possible may be recorded in more detail.

CASE I.—*Infected teratoma of the mediastinum. Chronic empyema. Discharging sinus of the neck. Removal of the teratoma. Recovery.*

A white woman, age thirty-nine, so far as she knows always previously healthy, developed a severe attack of acute tonsillitis early in December, 1921. About the middle of December she noticed a small, painful swelling at the root of the neck, just to the right of the suprasternal notch, and a dull pain in her right upper chest. There was no cough or expectoration. In January, 1922, the swelling in the neck was incised by her physician and some thick, cheesy material, containing hair, was evacuated. The fever and thoracic pain did not subside, however, and February 22, the patient was again operated upon. At this operation a rib or ribs were resected just to the right of the sternum; the pleura opened and pus obtained. At the same operation, a rib was resected rather low in the mid-axillary line and pus again obtained. Drainage tubes were inserted. The patient was ill in bed for eight months and lost 35 pounds in weight. The sinus to the right of the sternum healed, but the sinuses in the neck and the lateral thoracic wall continued to drain. She presented herself at the Cincinnati General Hospital, October 20, 1925. Physical examination showed an emaciated, somewhat septic woman, with a draining sinus in the neck and lateral thoracic wall, with clubbing of the fingers, dulness to the right of the sternum and impaired resonance over the lateral and postero-lateral aspects of the chest. X-ray examination showed a mediastinal shadow extending into the right thorax and a chronic empyema cavity. A close examination of the mediastinal shadow showed small denser areas suggesting bone, possibly teeth. In view of the history of the discharge of hair from the sinuses

in the neck and thoracic wall and the solidity of the X-ray shadow, a diagnosis of infected teratoma of the mediastinum was made. Injection of lipiodol into the neck and thoracic sinuses showed local collections within the tumor shadow which were interpreted as abscesses.

The surgical problem presented by this case appeared a difficult one. The presence of infection complicated matters greatly, for it promised to make more difficult the separation of the tumor from surrounding structures because of dense adhesions, and exposed the patient to the dangers of pericarditis, should the pericardium be opened, and to a widespread pleuritis. It seemed to us wise to attempt to limit the infection to the tumor or clear up the infection entirely if possible, before attempting its total removal. At the first stage of the operation, October 31, 1925, therefore, the costal cartilages, adjacent ribs and right lateral half of the sternum lying over the tumor, were resected. The upper pole of the tumor was freed and cut across opening up an abscess cavity the size of a walnut. This cavity communicated with the sinus of the neck. In sectioning the tumor, cartilage, bone and rudimentary teeth were encountered. The tumor was then freed along its right lateral border and posteriorly, in doing which another abscess as large or larger than the first, was opened. This was proven to communicate with the lateral thoracic sinus. The cavity was filled with drains which were brought out of the operative wound. Because of the patient's condition, the operation was terminated, and the wound partially closed. There followed a period of dakinization through the sinuses of the neck and thorax and operative wound. For a considerable period, there was a through-and-through communication between sinuses and wound; but subsequently after five months, April 19, 1926, communication ceased and both sinuses and wound completely healed. The chronic empyæmic cavity became obliterated. We were tempted to be content with this result, but the patient had meanwhile gained so much in weight and general well-being, that we decided to go on. At the second stage, the previous wound was re-opened and the tumor with great difficulty surrounded. It was so intimately fused with the great vessels and pericardium, that no line of cleavage was ever found. The tumor was therefore sliced off the vessels and pericardium, so that we undoubtedly left small fragments of tumor attached to them. In cutting through the tumor, a number of small abscesses were opened. There was little bleeding throughout the procedure. The wound was left partly open. The patient's convalescence was satisfactory, excepting for the development of a chondritis, necessitating two subsequent minor operations for the removal of infected cartilage. At the time of her discharge in March, 1927, the thoracic wound had not completely closed. There had been a gain of over 30 pounds in weight. A recent letter states she is remarkably well. The wound, however, is not yet completely healed.

CASE II.—*Hour-glass tumor (neuro-fibroma) of spine and chest. Symptoms of spinal cord tumor—mediastinal portion of tumor not recognized. Laminectomy. Removal of extradural tumor with its mediastinal extension. Recovery.*

## FURTHER EXPERIENCES WITH INTRA-THORACIC TUMORS

A man, age thirty-eight, was admitted with the complaint of paralysis of the legs. Up to the age of twenty-eight, his health had been excellent. For ten years he was very nervous, with frequent twitching of the muscles of his arms and legs. His present illness began two and a half years ago, with numbness in the sole of the right foot. Three days after the onset, the left foot became numb. The anæsthesia gradually extended up the legs, until at the end of a month, it had reached the knees. He next noticed that his toes dropped and that he was unable to flex the ankles. His walking became uncertain. Within six months after the onset of his illness, he was totally paralyzed and anæsthetic from the level of the xyphoid downward. There has been incontinence of urine and fæces for two years.

Examination showed complete paralysis of both legs but with transient spasm or jerking, usually involving the flexors and extensors alternately. There was moderate spasticity of both legs. The knee jerks were hyperactive, but there was no ankle clonus. A positive Babinski was present on both sides. Sensory examination showed anæsthesia over the lower half of the body, extending upward to a level corresponding with the eighth dorsal vertebra behind and the xyphoid in front. X-ray of the spine and chest were negative; but it should be said that an intra-thoracic extension of a tumor was wholly unsuspected and no special X-ray studies other than a flat antero-posterior plate, were made, to determine it. A diagnosis of spinal cord tumor was made.

A laminectomy was performed and a large extradural tumor was found lying under the sixth dorsal lamina and to the left of the midline. It had eroded and largely destroyed the sixth dorsal lamina and had extended forward, eroding the body of the vertebra and enlarging the intervertebral foramen. A spinal nerve ran into the tumor and emerged from it; and as the tumor had no other connection, it was assumed that it arose from the nerve. As the tumor was followed forward, it became necessary to remove the articular ends of two ribs and the articular processes of the vertebræ. It became evident that the tumor extended into the mediastinum, pushing the left pleura forward. The pleura was not attached to the tumor which was eventually delivered intact. It was interesting to note the suction exerted upon the tumor by the thorax. As soon as traction upon the tumor was released, the tumor was sucked back into the thorax with surprising force.

The patient made an uninterrupted recovery. There was a prompt return of motion in the legs. Within six months, he was walking about. He has been well over four years.

The tumor was of the hour-glass shape and on section proved to be a neurofibroma or endothelioma.

*CASE III.—Right apical tumor. Symptoms of pain in shoulder, radiating down the arm. Ptosis. Physical and X-ray evidence of apical tumor. Radical removal of tumor. Recovery. Recurrence.*

A man, aged thirty-one, was admitted to the Cincinnati General Hospital, September 21, 1925, complaining of pain in the right chest and shoulder, radiating down the arm. His previous health had been good. In June, 1925, he began to have pain in the right shoulder and right scapular region, radiating down his right arm. This came on periodically and gradually grew more intense. It has always been worse when lying down and is relieved by the upright position and by motion. There has been some pain in the right upper chest. Lately he has had a dry cough, especially upon arising in the morning. There has been some, though slight, loss in weight.

Examination showed a rather pale individual, in no apparent distress. There was fulness of the right upper thorax, restriction in respiratory movements over the same region, dullness on percussion down to the fifth rib anteriorly and to the scapular space posteriorly. Over the dull area, the breath sounds were diminished. There was evident ptosis of the right upper eyelid, slight contraction of the pupil as compared with the left, but no evident enophthalmos. Both radial pulses were present and of equal

volume. The right arm was slightly larger than the left, showing a difference of 4 cm. in circumference. There was cutaneous hyperæsthesia over the arm, but no other sensory changes. Muscular power good. The supra-clavicular veins on the right were somewhat prominent. The examination otherwise was essentially negative. X-ray of the chest showed a large circumscribed tumor of the right apical region.

Operative therapy was advised but refused. The patient was given a series of deep X-ray treatments with definite diminution in the size of the tumor, and increase in weight and a decrease in pain. This improvement, however, was only temporary. Six months later he was readmitted with his symptoms more pronounced than on the previous admission, with an increase in the size of the tumor and with paralysis of the diaphragm.

Operation was performed March 27, 1926. An incision was made anteriorly over the third rib, from the middle of the sternum to the axilla. The pectoralis major was split and about 6 inches of the third rib resected. The posterior periosteum of this rib was incised and the pleural cavity opened. The apex of the lung was attached to the lower pole of the tumor, but could be separated from it. It became apparent that the tumor could not be removed through the opening so the costal cartilages of the second and fourth ribs were divided transversely, close to the sternum, a procedure which, with a strong rib spreader, allowed an adequate exposure. Closer examination of the tumor showed it to be covered by the partial pleura, which was intimately connected with the capsule of the tumor. The tumor was satisfactorily surrounded to a small area, where it was densely and intimately fused with the subclavian vessels. Here, in attempting to separate the mass from the vessels, the capsule of the tumor was ruptured. From this point on, an intra-capsular removal seemed the only possible procedure. The tumor was completely removed except for a narrow strip of capsule attached to the subclavian vessels. There was surprisingly little bleeding during the procedure. The wound was closed without drainage. The diagnosis of the tumor was myxo-sarcoma.

Post-operative convalescence was satisfactory for a time. An effusion subsequently developed, which was tapped several times. Finally, a tube was inserted, after culture from the aspirated fluid showed staphylococcus. Five months after operation, an enlarged gland was found in the right axilla, which was taken to be a metastasis. X-ray of the chest showed a recurrence of the apical tumor. The patient from this time on, steadily went down hill and died within a year from operation. An autopsy was not obtained.

**SUMMARY.**—Of the 33 cases in the first and second series, two cases not tumors but an aneurism and a mediastinal abscess have been described because they illustrate the difficulties in diagnosis and were operated upon with the mistaken diagnosis of tumor. The 31 true tumors of the thorax included:

- (1) Three sarcomas of the bony thorax (ribs).
- (2) Ten tumors of the mediastinum including
  - (a) Two congenital tumors, one teratoma; one calcified dermoid cyst.
  - (b) Four benign tumors, one xanthoma; one chondro-myxoma; two undiagnosed.
  - (c) Two malignant tumors, probably sarcomas or thymomas.
  - (d) Two mediastinal Hodgkin's disease.
- (3) Six tumors of the pleura including
  - (a) Three diffuse endotheliomas of the pleura.
  - (b) Three circumscribed endotheliomas of the pleura.

## FURTHER EXPERIENCES WITH INTRA-THORACIC TUMORS

- (4) Nine tumors of the lung including
  - (a) Three primary carcinomas, one possibly an endothelioma.
  - (b) Four primary sarcomas, one possibly an endothelioma.
  - (c) Two metastatic sarcomas in which pulmonary symptoms were predominant.
- (5) Two hour-glass tumors involving the thorax and spinal cord, one a neuro-fibroma, the other not verified.
- (6) One apical chest tumor diagnosed as myxo-sarcoma.

Of the 31 cases, 15 were subjected to operation. In 14 of the remaining 16 tumors, the lesion was so advanced or of such a nature as to preclude operation; in two obviously benign lesions, the patients refused operation. In the 15 cases subjected to operation, the operation consisted of a radical removal of the tumor in nine, a partial removal or the drainage of infectious complications in five. There was one operative death occurring in the group subjected to radical operation. Of the cases subjected to radical operation, eight recovered, and of these, one (benign) is living ten years, one (benign) eight years, one (benign) six years, two (malignant) over two years, one (benign) less than one year. Two (malignant) died of recurrence within a year. Of the cases treated by partial removal, one lived over two years, the remainder died in about a year.

Of the 31 intra-thoracic tumors seen by me, only 11, or 35 per cent., were possibly operable. The mortality in those subjected to radical operation was 10 per cent. and the results not too pessimistic. Our experience warrants the assumption that with earlier diagnosis and earlier operative treatment, the surgery of intra-thoracic tumors may be greatly improved.

# THE THORACO-PERITONEAL OPERATION FOR HERNIA OF THE DIAPHRAGM\*

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THE surgical mortality in dealing with diaphragmatic hernia varies from 5 per cent. to over 50 per cent., depending upon the physical state of the

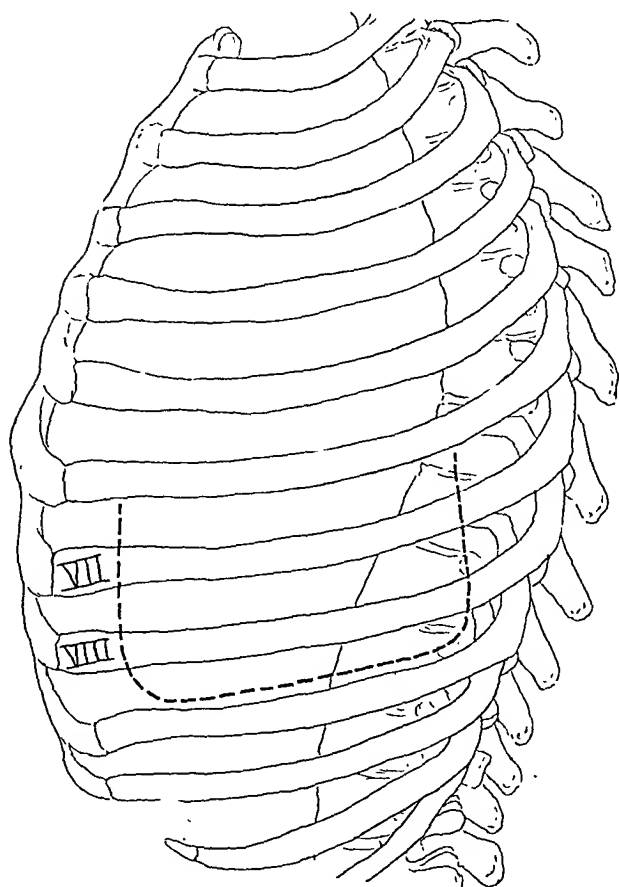


FIG. 1.—Interrupted line indicates the line of incision, including all layers of the thoracic wall.

hernia revealed at the time of operation. When the stomach alone is involved it may become incarcerated, but not strangulated. Therefore, operation in this class carries a small risk. On the contrary, when the operation is undertaken for acute intestinal obstruction the mortality rate reaches the peak, unless a surgeon is called upon to deal with the situation early and finds conditions favorable. It is higher than the mortality for acute intestinal obstruction in general, because the operation for hernia of the diaphragm is not complete unless the aperture is closed. In accomplishing this the extra time and technical difficulties to be surmounted present a real hazard in the picture.

To eliminate the danger of a major operative procedure and thus reduce the mortality from 50 per cent. to 5 per cent. is something to be desired. It can be done by a two-stage operation. First, an appendicostomy or cæcostomy to relieve the obstruction, and secondly, the operation for repair at a time of election. Here the application of the principle of the two-stage operation has special significance, since according to C. H. Mayo's observation the colon was found above the diaphragm in 12 cases out of 22. Hedblom's analysis of 343 cases also revealed the important fact that in more than 50 per cent. of these cases the colon was involved in the hernia.

Although the stomach and small intestines may pass through the opening in the diaphragm with the transverse colon, when constriction occurs the

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seat of obstruction almost invariably is in the transverse colon. This liability no doubt is due to the inspissation and accretion of the contents of this segment of the intestine.

The preliminary operation of appendicostomy or cæcostomy promptly relieves the obstruction. If it so happens that the diagnosis of diaphragmatic hernia has been established, this minor operation eliminates the necessity of laparotomy and allows adequate time to prepare the patient for the major operation of repair. In addition, it provides a safety valve in case of recurrence or during convalescence when pressure against the reconstructed diaphragm from distended gut below can be reduced to a minimum. The use of the stomach tube before and after operation is also of great value, especially in those cases which involve the stomach alone.

An interesting case with obstruction was reported by Frank S. Mathews in 1920 (*Trans. Amer. Surg. Assn.*, vol. xxxviii, p. 614), another by John H. Jopson, (*Trans. Amer. Surg. Assn.*, vol. xxxviii, p. 625). In this case acute intestinal obstruction recurred twenty-four hours after the colon had been reduced by the peritoneal route. Jopson discovered the hernia in the diaphragm by an abdominal approach. He found it necessary, however, to supplement the abdominal incision by a thoracotomy in order to reduce the bowel, and sutured the diaphragm from above. A case described by Bevan (*Trans. Amer. Surg. Assn.*, vol. xxxviii, p. 623) involving the transverse colon was readily reduced and the aperture closed without difficulty. His patient died soon after operation from acute obstruction, which persisted on account of a circular carcinoma of the splenic flexure found at autopsy. Under circumstances of this sort a preliminary cæcostomy would relieve acute obstruction and permit opportunity for the röntgenologist to discover the neoplasm at the splenic flexure.

It is probable that, in more than 90 per cent. of the cases of dia-

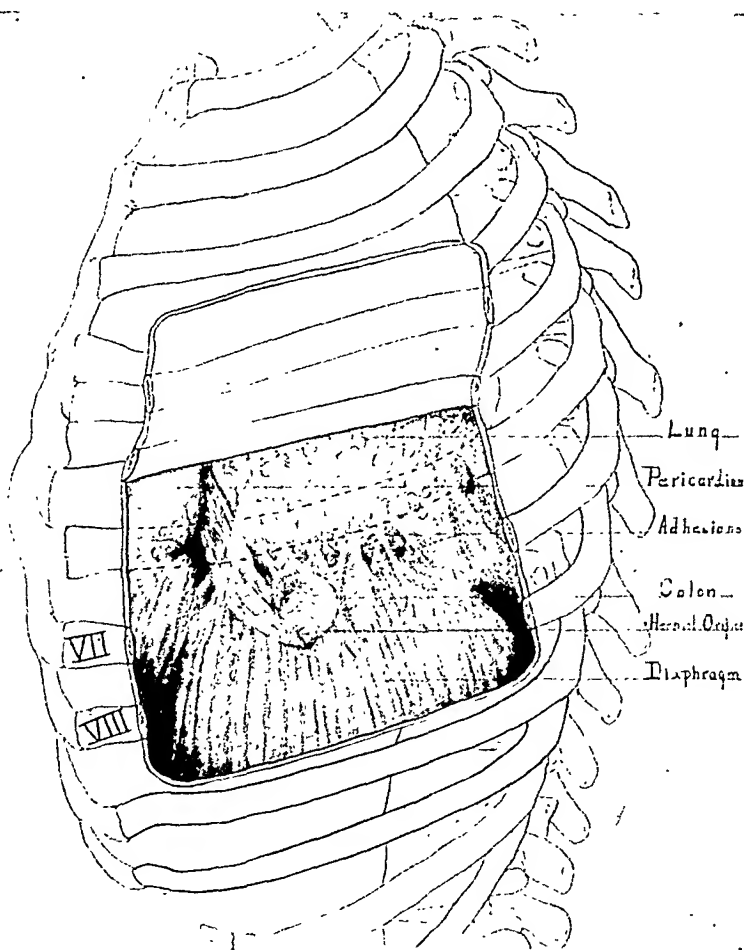


FIG. 2.—With the flap turned upward on its base, a large window is provided for dealing with the structures which come plainly into view.

phragmatic hernia which come to operation, all the entanglements above and below the diaphragm can be negotiated safely by either one of two approaches, the peritoneal or the thoracic. After a careful consideration of all the evidence in his case it is customary for the surgeon to adopt a plan of procedure which appears to be the most rational for him to undertake. Occasionally, on account of the difficulties encountered, it has been found necessary to abandon the chosen method and later operate again by another approach. Frank (*ANNALS OF SURGERY*, March, 1920,) found it necessary

to abandon the attempt by laparotomy and at a second operation successfully closed the aperture in the diaphragm through an opening in the chest wall.

Another case of unusual interest was reported by Harvey B. Stone. The patient was operated upon for acute intestinal obstruction by Dr. Charles H. Watt who reduced the herniated colon without subsequently closing the opening in the diaphragm. Later examination revealed the presence of the colon in the left thoracic cage. Doctor Stone operated upon

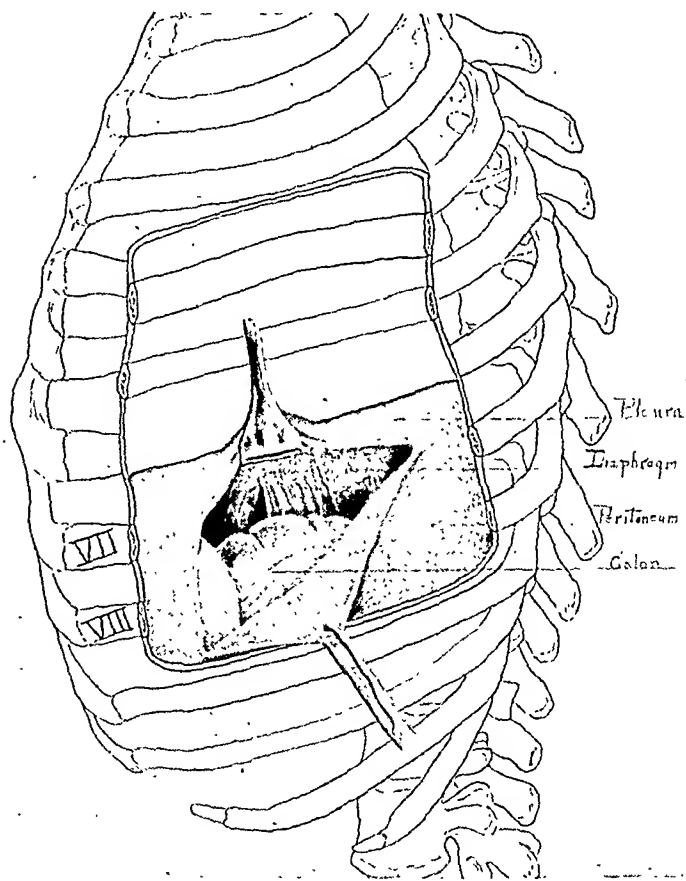


FIG. 3.—The right angle incision opens the serous cavities below the diaphragm as well as above it.

this patient through a high rectus incision, but found reduction of the incarcerated colon impossible. He then performed thoracotomy, exposing the upper surface of the diaphragm, after which he incised the constricted ring, bimanually reduced the herniated bowel and successfully closed the opening in the diaphragm. This operation he has described as the "Abdomino-thoracic Approach" (*ANNALS OF SURGERY*, July, 1923, p. 32).

Several other surgeons, including Greig, Granger, Mawson Ray, Weat and Dujarier have reported cases in which it was found impossible to close the opening in the diaphragm completely by the peritoneal approach. Fewer failures in completing the operation have been reported by those who selected the thoracic approach.

Among the French surgeons who invariably employed the transthoracic



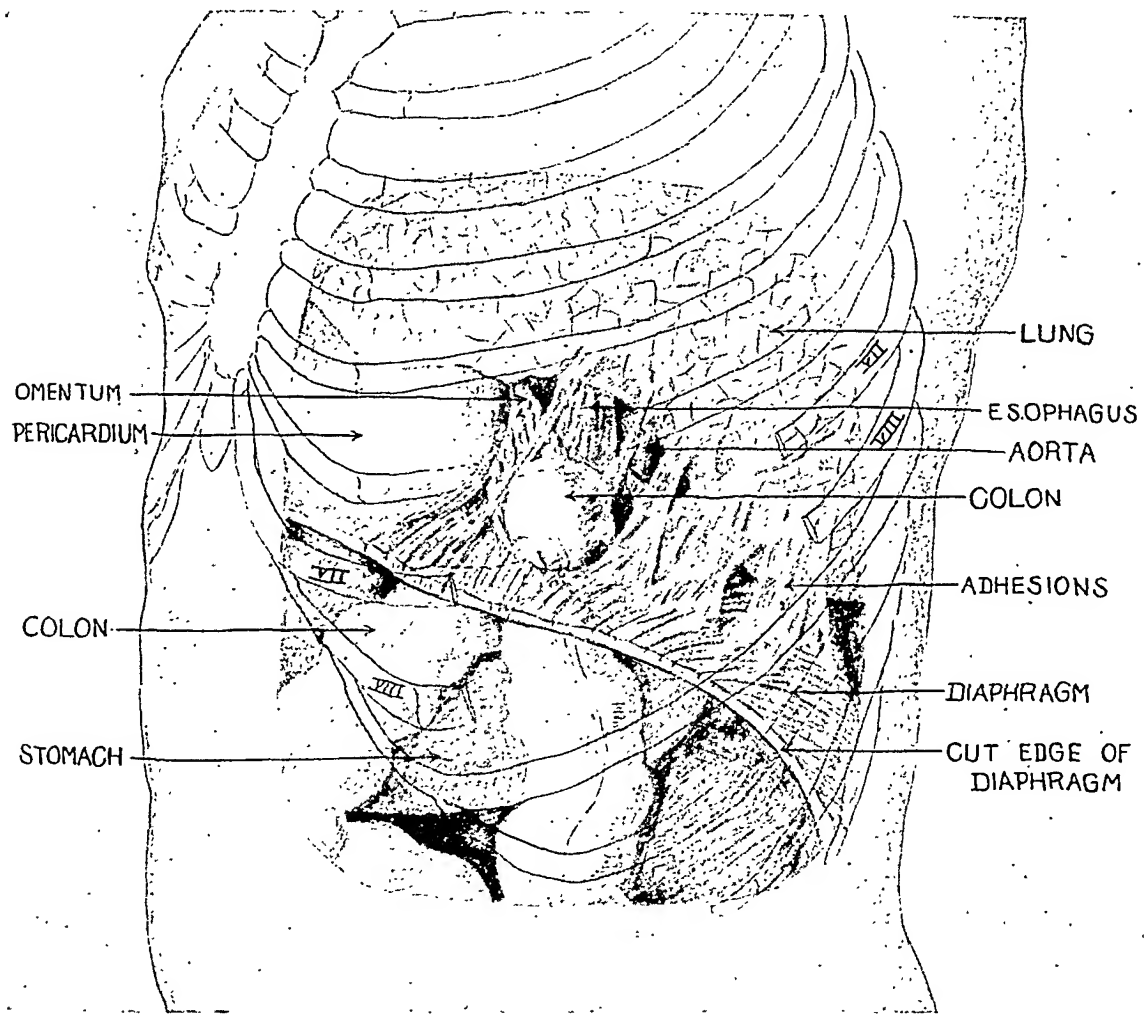


FIG. 4.—The section through the diaphragm portrays the conspicuous rôle of the transverse colon and omentum in the case reported above.

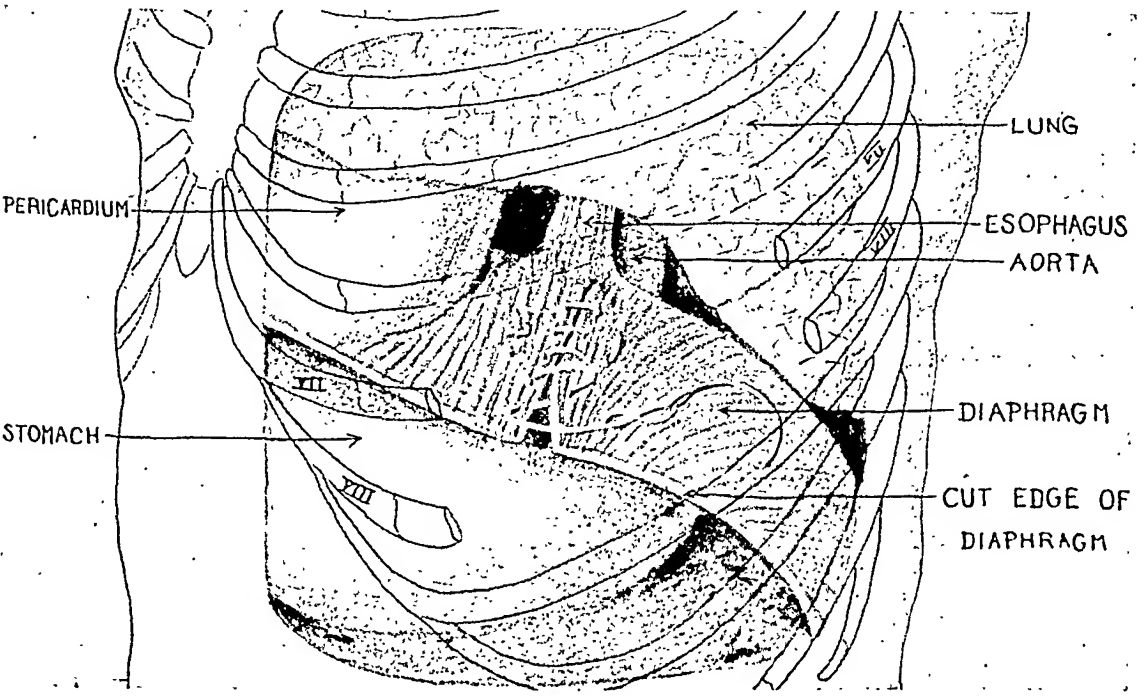


FIG. 5.—Aperture repaired by a running suture of chromic catgut, reinforced by mattress sutures of the same material.

approach Bedard and Auvray were the first to combine the opening of the pleural cavity and the peritoneal cavity by means of one incision. Bedard used the right-angle incision giving entrance to both thorax and abdomen. His case was one of strangulated hernia and came to autopsy. Auvray (*Bull. de la Soc. Chir.*, 1919, p. 698) was the first to employ the thoraco-peritoneal incision successfully. By means of a thoracic approach alone he was unable to free adhesions by the use of the bistoury, so he used a right-angle incision 41 cm. long, resecting the ninth rib and extending downward nearly to the umbilicus. On the twelfth day he was obliged to open the pleural cavity to evacuate sero-sanguinous fluid. I have not found this exact method of approach described elsewhere in the literature on surgery of the diaphragm.

The following case presents the combined problems of this singular anomaly in the form of a congenital hernia of the diaphragm with extensive adhesions above and below the aperture.

The patient was a girl aged six years, who was admitted to the Brockton Hospital in March, 1925 for acute intestinal obstruction. She was operated upon by Dr. Samuel Goddard. A diaphragmatic hernia was found and reduced, but owing to the inaccessibility of the opening in the diaphragm, no attempt at closure was made. After remaining well for nearly a year, in February, 1926, she awoke at night with severe abdominal pain and vomiting. She was readmitted and operated upon. Again the hernia was reduced, but an attempt to suture the opening in the diaphragm presented too many difficulties.

On March 14, she was admitted to our hospital. Röntgen-ray examination revealed a loop of the transverse colon above the diaphragm and located near the œsophagus. A preliminary appendicostomy was done on March 20th. On April 2 an attempt was made to close the opening in the diaphragm through an abdominal incision along the left costal margin. Although liberal in extent, this opening did not allow sufficient access to the hernia orifice to justify an attempt to deal with the incarcerated loop of colon which was found fixed at the point of constriction in the diaphragm. Since the hernia could not be reduced by traction of moderate force, the operation was abandoned. On April 26 a thoracic approach was made by means of a lapel incision over the sixth, seventh and eighth ribs. This flap of chest wall, including ribs, muscles and pleura was turned upward allowing an extensive exposure of the diaphragm. The mass representing the contents of the hernia included the colon and omentum. Difficulty was met in dealing with the adhesions at the ring, so the inner angle of the parietal incision was continued downward in a vertical direction opening the peritoneal cavity and exposing the under surface of the diaphragm. In order to expedite reduction of the colon and omentum, the diaphragm was split from the aperture toward the periphery. The adhesions thus were more readily released and the bowel and omentum replaced in the peritoneal cavity. The opening in the diaphragm was closed from the lowest point toward the periphery by running suture of chromic catgut reënforced by mattress sutures of the same material. The patient made an uneventful recovery. One year later she returned for closure of the appendicostomy. She had been well throughout this period since her operation.

#### TECHNIC OF THE THORACO-PERITONEAL OPERATION

The first steps of this operation should be conducted on the assumption that it will not be necessary to open the peritoneal cavity. In most cases a liberal exposure of the diaphragm through the chest wall will permit a complete reduction of the hernia and closure of the orifice without difficulty.

In any case it requires no more time to provide a large window in the thoracic wall. This is done by employing the lapel incision. Beginning at the lower edge of the sixth rib in the posterior axillary line, the skin is divided in a downward direction over the seventh and eighth ribs, where it makes a right angle turn and follows the eighth intercostal space in a forward direction until it reaches the cartilaginous portion where it turns upward, again crossing the seventh and eighth ribs, thus outlining a trap-door. The skin is not dissected off the parietal wall. Returning to the point of beginning the incision is carried through all layers of the chest wall including the pleura. The seventh and eighth ribs are severed in the path of the knife which follows the line of the original skin incision. The flap is thus completed and turned upward on its base. When it is deemed necessary to expose the underside of the diaphragm the vertical incision near the left border of the sternum is continued downward through the left rectus muscle for about six to eight centimetres. Incising the peritoneum, the diaphragm is then exposed above and below in such a manner as to permit the separation of all adhesions directly under the eye. The sac, if there is one, can be removed readily and its contents replaced below, thus permitting a speedy closure of the aperture. As in the case described above, it may be considered of advantage to split the diaphragm from its anterior edge down to the hernial orifice. This gives the appearance of a somewhat radical step, but it permits a better access to the ring and facilitates its closure, with a running suture of chromic catgut. This line is supported by mattress sutures of the same material. The peritoneal wall is then closed. The thoracic flap is then turned back in its place and closed tight with interrupted sutures of silkworm gut.

SUMMARY.—The two factors in dealing with diaphragmatic hernia which I wish to present in this paper are:

1. The two-stage operation in all cases involving the colon.
2. The thoraco-peritoneal operation as an added resource in time of need.

# THE CHANGING STATUS OF ANÆSTHETICS\*

BY GEORGE P. MULLER, M.D.

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NO CHAPTER in the history of Medicine is more fascinating than that relating to the development of anæsthesia. The literature now has assumed vast proportions and it is only possible to point out here and there certain events and names which have served as milestones in the path of progress. After the discovery of hydrogen, oxygen, nitrogen and nitrous oxide, whisperings were in the air, but nearly seventy-five years elapsed before Bigelow in 1846 made formal announcement of the discovery of ether as a surgical anæsthetic.

One year later Simpson's famous pamphlet on chloroform appeared and the claims for ether were challenged by the less irritating chloroform which maintained the advantage in England for many years and even in the United States was favored in the South and West until comparatively recently. In 1858, John Snow published the result of his work on animals showing the physiological effects of ether and chloroform, this being the earliest first-class piece of experimental work to be done but a good deal of the literature of the next decade was concerned with different types of inhalers and controversy as to whether anæsthetics had reduced or increased the mortality of surgical operations.

As early as 1800, Davy ventured the suggestion that nitrous oxide might be used during surgical operations, but the dentists, led by Colton, discovered its great value in 1863, and when in 1868, Andrews, of Chicago, suggested the admixture of oxygen to prevent asphyxiation, the medical profession was skeptical to the suggestion and nitrous oxide as a surgical anæsthetic lapsed.

In 1879, the first committee of the British Medical Association pointed out the danger of chloroform, and in 1881, Agnew considered ether as the anæsthetic of choice and believed that, generally, chloroform should be banished from surgical practice. He noted that nitrous oxide was quite unsuited to the purpose of general surgery. About the same time Gross stated a preference for ether on the ground of greater safety, but from the wording of his sentences one gathers the impression that chloroform was dear to his heart. He also believed that nitrous oxide could not be employed safely in protracted operations.

During the period from 1880 to 1900 the physiological aspects of ether and chloroform anæsthesia were studied but there was little progress. In 1897 the A.C.E. mixture began to have a vogue but in 1897, Horatio Wood wrote that the surgical profession had practically settled down to the employment of either ether or chloroform, and John Ashhurst (1897) taught that

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\* Read before the American Surgical Association, May 13, 1927.

ether was the anæsthetic of choice, nitrous oxide being seldom employed in general surgery except as a preliminary to the administration of ether. The ether-chloroform controversy was active, however, and in 1896 Caldwell (*Jour. A. M. A.*, 1896, vol. xxvii, p. 1289) sent a questionnaire to surgeons north of Baltimore and St. Louis. New York, Philadelphia and Boston used ether exclusively, Chicago was about equally divided, St. Louis was 75 per cent. for chloroform and further west chloroform was still more popular.

But as early as 1889, Gersuny reported eight major operations performed under nitrous oxide anæsthesia, Hewitt was giving gas, even for amputation, and by 1895 nitrous oxide induction preliminary to ether was being referred to in our literature. In 1898, Lilienthal (*ANNALS OF SURGERY*, 1898, vol. xxvii, p. 583) wrote an excellent paper on local and nitrous oxide narcosis and reported four major operations done under gas. He reported a number of operations with eucaine, an anæsthetic just discovered. In 1900, Goldman (*Jour. A. M. A.*, vol. xxxiv, p. 708), of New York City, wrote a rather advanced paper for the time on the use of nitrous oxide anæsthesia in prolonged surgical operations. He advised the nitrous-oxide-oxygen-ether sequence in abdominal operations, wrote of certain advantages of carbon dioxide rebreathing from a bag and of the admixture of oxygen with the gas. Parenthetically, it is interesting to recall that in 1894, W. J. Mayo reported that he had performed seven operations on the gall-bladder and biliary tract and Deaver and Murphy were starting the campaign against the appendix.

In 1901, Crile (*Southern Med. J.*, 1901, p. 20) began publishing the series of papers revolving about the use of nitrous oxide as an anæsthetic and stated that he had used it in 575 major operations. Apparently at first he did not combine it with oxygen but did use morphine-scopolamine as a preliminary. In the same year Bennett (*Ref. Handbook Med. Sc.*, 1901, vol. iii, p. 19) was uncertain as to the safety of nitrous oxide and oxygen for prolonged administration.

The extended use of nitrous oxide was somewhat delayed by the introduction of the so-called "open-drop" method of administering ether, first developed by Prince in 1893. This method was largely popularized by visitors returning from the Mayo Clinic where Alice Magaw gave preference to ether and wrote in 1906 that ether comprised 92 per cent. of the anæsthetics given during the year 1905. Prior to the open-drop method various inhalers and cones had succeeded the apparatus of Clover which had followed the flask of Morton, and it is interesting to recall that Clover made use of the modern principle of rebreathing, but the method was given up in the '90s because it was thought that the rebreathing of exhaled gases poisoned the patient.

If we turn back a few years we find the sources of a new method of anæsthesia and one destined to forge up to the front rank. In 1880, Von Anrep suggested the possibility of cocaine by injection as a surgical anæsthetic, but the idea was not followed up. In 1884, Koller demonstrated the anæsthetic properties of this drug on the eye and his paper attracted world-

wide attention. In the same year Halsted injected a solution of cocaine along the course of sensory nerves and operated for talipes by this method. In the following year Leonard Corning, of New York, injected cocaine on to the dural sheath of the cord, the forerunner of the modern sacral anæsthesia, but it was not until 1898 that Bier introduced the present method of injection into the sub-arachnoid space. In 1894, Schleich introduced the use of dilute solutions of cocaine and in 1897 eucaine was discovered, the first of a long line of similar local anæsthetics. Casey Wood brought Schleich's solution to the attention of American surgeons, and this marked a distinct advance because a long list of fatalities had been reported from the use of stronger solutions.

In 1900, Matas published his masterly paper on local and regional anæsthesia and called attention to the fact that Crile had amputated a leg in 1897 after injecting the sciatic and anterior crural nerves. Matas made the following remark: "With Lilienthal, I would say that we have accustomed ourselves to ether and chloroform to such an extent that only in very exceptional cases do we think of the possibility of doing serious surgical work without them. Yet there are many major operations which can be better and more safely done with the help of local anæsthetics, and it is merely the force of habit that keeps us in the old rut." Abroad, many operations were done under local anæsthesia and Kocher was routinely doing thyroidectomies by this method, but in this country except for minor procedures the method made slow progress, and even in 1914 Balfour stated that during 1913 they had performed *several* abdominal operations under novocaine alone.

In 1910 a great impetus was given to gas anæsthesia by the publication of Crile's anoci association technic and most of us who visited his clinic were deeply impressed by the smoothness of the anæsthesia.

About this time two events occurred in this country that had an important bearing on the anæsthesia question. In 1911, this association had a symposium on anæsthesia and Bevan, Gatch, Meltzer, Henderson and Crile read the papers. Among Bevan's conclusions he stated: That for routine work, open drop ether is the safest and most satisfactory anæsthetic, and in the usual run of good surgical risks it is the anæsthetic of choice in from 75 to 80 per cent. of the cases. Nitrous oxide should not be preferred to ether in the ordinary prolonged operation in patients who are good surgical risks. Local anæsthesia has a limited field of usefulness. Spinal anæsthesia has little or no place in surgery. The use of morphine and scopalamine before a general anæsthetic should be abandoned or limited to specially selected cases.

On the other hand, Crile gave us the official presentation of his principle of anoci association. He urged the use of morphine and scopalamine especially on the ground that it depressed the faculty of associated memory and thus abolished fear. He urged the use of nitrous oxide and oxygen as minimizing shock by limiting oxidation in the brain tissue.

Gatch revived the old principle of rebreathing as exemplified in the

Clover inhaler. The use of the closed inhaler permitted a certain amount of rebreathing, but when the open method came into use it was considered a great advance in that the patient could get rid of the  $\text{CO}_2$  more easily. The physiologists; especially Henderson, then showed there were no organic poisons in the expired air and that  $\text{CO}_2$  was not only harmless but useful. This led Gatch in 1910 to advocate the deliberate use of rebreathing as an aid to good anæsthesia, the gas machines were changed to fit the Gatch principle and at the same time McKesson introduced the principle of fractional rebreathing.

In 1907, the Anæsthesia Commission of the American Medical Association was formed and in the following year Mumford made the preliminary report. They believed that open-drop ether was the safest anæsthetic, and regarded the use of nitrous oxide with air throughout major operations as a novelty. Haggard reported that he had performed three major operations under nitrous oxide and Mitchell wrote an excellent report on the use of local anæsthesia stating that "except for strictly minor operations, the use of local anæsthesia in America is limited to a few clinics." This commission made its second report in 1912 and put the final quietus to any official claim for chloroform in this country, believing that in neither major nor minor surgery there was any justification for its use. Yandell Henderson was the chairman and his well-known views regarding acapnia led to the strong approval of the principle of re-breathing and the use of  $\text{CO}_2$  mixed with the oxygen. To me, the most important point made by them was that ether anæsthesia should always be induced quickly and thereafter kept as nearly uniform as possible. In 1912, Gwathmey (*Jour. A. M. A.*, 1912, vol. lviii, p. 465) attacked the ether drop method, preferring the use of vapor. It is interesting to note that at this time he believed that "as a broad general proposition, and when properly administered, ether or chloroform anæsthesia is as safe and also as free from after-effects as is a nitrous oxide and oxygen anæsthesia." In 1914, he advocated a nitrous oxide-oxygen-ether sequence. But open drop ether was the method of choice in the clinics of Mayo, Bevan, Murphy and Deaver. At the Mayo Clinic, McGrath (*St. Paul Med. J.*, 1914, p.83) found that from 1900 to 1913, ether was used in 94 per cent. of the anæsthesias. After 1907 chloroform was only used once. Henderson (*St. Paul Med. J.*, 1914, p. 74) wrote that "to-day we are going through a curious phase in the use of anæsthetics, namely, a return to narcotics, inefficient nitrous oxide, and local anæsthesia, a combination which has the bad qualities of all three, and in which the local anæsthesia does most of the work." In 1910, Meltzer brought up the possibilities of endotracheal anæsthesia and the method was adapted to clinical use by Elsberg. I was among the guilty ones who devised an apparatus for this purpose and for several years was very partial to it for operations on the mouth and neck. Shipway in England still uses it and in 1921 reported an experience of 930 cases. But during the War Gwathmey and Bunnell showed that positive pressure could

be obtained with the gas mask and Graham's studies minimized the dangers of acute pneumothorax.

In 1915, Bevan again (*Jour. A. M. A.*, 1915, vol. lxxv, p. 1418) concluded that "drop ether" should be considered as the standard general anæsthetic and that gas should be chosen in short anæsthesias in which unconsciousness is desired and especially when there is kidney insufficiency. He favored local anæsthesia with novocain but did not believe its range should be stretched too far. He rejected spinal, intravenous and intrarectal methods. He rejected both the theory and practice of anoci association. But in some clinics gas-oxygen was in high favor. For instance, in 1912, Prince (*Jour. A. M. A.*, 1912, vol. lvi, p. 1342), of Birmingham, Ala., reported that he had operated on 2000 patients under gas-oxygen alone during four years, most of them major surgical procedures. For various reasons nitrous oxide and oxygen continued to grow in favor and by 1918 was soundly established as a standard anæsthetic and in sharp conflict with ether for supremacy.

Since the introduction of the method by Bier in 1898 spinal anæsthesia has had a steady but slight vogue, although a few men, notably Babcock in this country, have made extensive use of it. The improved methods of inducing local anæsthesias have reduced its selection even in strangulated hernia and in prostatectomy.

In the 1911 discussion on anæsthesia before this association Nancrede made a plea for chloroform in war surgery and said it was absolutely foolish to talk about giving ether after a big battle because enough ether could not be carried. When the war came three years later ether was supplied after the second month and gas machines and the Shipway apparatus were freely used.

During the war nitrous oxide and oxygen received a great impetus as an anæsthetic for shocked patients and local anæsthesia was more freely used than ever, especially for abdominal and head injuries, Cushing showing that extensive operations on the cranial cavity could be done under local anæsthesia and the idea was carried over into civil surgery, Elsberg recently reporting that he did 63 per cent. of major craniotomies under local anæsthesia.

The use of local anæsthesia on the surface and the early infiltration methods were comparatively simple, but when its use was extended to the abdomen and chest the problem became complicated and led to a minute study of the anatomical pathways and the sensory nerve apparatus. When it was found that the sympathetic alone carries sensory impulses from the abdominal organs, the problem resolved itself into an attempt to block the sympathetic ganglia. In 1913, Kappis injected the splanchnic nerves as they enter the semilunar ganglia and his results aroused the efforts of others, notably Braun and Wendling. In this country Labat called attention to splanchnic anæsthesia about five years ago. He believes that it has a very great field, without contra-indications. Blake (*J. A. M. A.*, 1924, vol. lxxxiii, p. 427), on the other hand, objects to the Kappis technic as being unreliable and dan-



gerous. Farr (*J. A. M. A.*, 1924, vol. lxxxiii, p. 429), as well as Blake, prefers an anterior sympathetic anæsthesia. In several papers published very recently by Lundy (*Surg. Clin. N. Amer.*, 1925, vol. v, p. 887; *Ibid.*, 1926, vol. vi, p. 1385; *Minn. Med.*, 1926, vol. ix, p. 399) from the Mayo Clinic it was shown that splanchnic anæsthesia was satisfactory in about 55 per cent. of the cases. He believes that its use is justified in certain well-selected cases, or when general anæsthesia is almost entirely contra-indicated. I note from his 1926 paper that apparently the method is less popular than it was earlier and he is "convinced that balanced anæsthesia is a more uniformly satisfactory anæsthesia than that provided by posterior splanchnic block." My own experience is limited to twelve cases. We are fearful of the great drop in blood-pressure which almost invariably occurs.

In 1917, Cotton introduced the ether known as Cotton Process ether. Standard ethers contained about 1 per cent. of ethylene, but this ether contained 2 per cent. and its virtues were supposed to be due to the action of this gas as a synergist. It is interesting that Lumbard in 1920 (*Am. J. Surg. Anæsthes. Supp.*, 1920, vol. xxxiv, p. 117) queried the possibilities of the ethylene as an anæsthetic but dismissed it as being an inert gas similar to nitrogen. Brown (*Canad. Med. Assoc. J.*, 1923, vol. xiii, p. 210) and simultaneously Luckhart and Carter (*Jour. A. M. A.*, 1923, vol. lxxx, p. 765) experimented with this gas in 1923 and the publication of their reports has led to a wave of enthusiasm over its merits. Abroad, acetylene has had a vogue. Ethylene has been used in my clinic since July, 1925, and we have observed all of the advantages claimed for it by Dean Lewis and others. The most serious objection to its use is the possibility of an explosion, but this can be minimized by certain precautions. Following a preliminary report in 1926, Sherman (*Jour. A. M. A.*, 1927, vol. lxxxviii, p. 1228) recently has reported in full his investigation of contamination of ethylene by carbon monoxide and believes it may constitute a real hazard. After the appearance of his paper last June, Dr. Selling Brill of our clinic examined seventeen of the tanks used and failed to find any evidence of carbon monoxide.

My own experience with anæsthesia began in 1904 when I first began to operate and at first practically all operations were done under straight ether by the open drop method. In 1905 we began the induction with nitrous oxide in the University Hospital, but for many years nitrous oxide-oxygen was only used alone for minor operations. About 1915, I began occasionally to use gas for major surgery and a year later was able to carry a subtotal gastrectomy through by this method with the addition of a very slight amount of ether. The table on page 250 shows the later progress of the clinic, the figures being given in percentages as the operations of the first year numbered 844 and during the fourth year 1132.

During 1926, in nearly all abdominal operations in which gas (nitrous oxide or ethylene) was used there was a reinforcement with local novocaine for the abdominal wall. Local infiltration anæsthesia is used alone for many cases of chronic appendicitis and hernia, for gastrostomies, enterostomies,

and colostomies, etc. It is usually used for acute empyema and for limited thoracoplasty. Simple cholecystostomy is sometimes done under local.

Gas anæsthesia, and almost always ethylene now, is the next anæsthetic of choice in my clinic. We never hesitate to add a little ether at times to

*Table, in Percentages*

	Sept. 1922-23	Sept. 1925-26.
Local, novocaine .....	10	22
Straight ether .....	43	11
Nitrous oxide—O .....	25	33
Ethylene .....	0	15
"Gas" ether .....	17	14
Miscellaneous .....	5	5

secure relaxation but try to avoid it in the presence of shock, acute toxæmia, diabetes, jaundice, exophthalmic goitre, and deficient kidney function.

Straight ether is used in small children, in operations about the face, and when relaxation is impossible from the other gases.

Special methods such as para-vertebral injections for thoracoplasty, splanchnic anæsthesia, sacral anæsthesia, and spinal anæsthesia, are only occasionally made use of.

Personally, I prefer inhalation anæsthesia and the nitrous oxide-ethylene-ether-local sequence is the choice, cutting out the ether whenever possible. All patients received morphine and atropine one-half hour before operation, unless contra-indicated. I have always been a firm adherent of the principle of Crile that the abolishing of the brain impressions during operation is a good thing for the patient. However, I find that I must use local anæsthesia more frequently than I like because of the wish of the patient and the preference of the medical advisers. Each year we have an increasing percentage of patients who refuse ether and together with the greater all-round safety of nitrous oxide and ethylene this will lead in time, I believe, to the relegation of ether as a straight anæsthetic to the obscurity which now envelops chloroform.

No mention has been made of the physiologic or pharmacologic aspects of anæsthetics in this rapid and cursory review. Steadily through the years innumerable observations have been made through experiment and such have had a pronounced influence on the practice in the larger clinics which has then radiated to general surgical practice. No mention has been made of endotracheal or rectal anæsthesias because after all they are only methods for inducing ether anæsthesia.

In conclusion, I believe that to-day, local anæsthesia and gas anæsthesia (nitrous oxide and ethylene) each with its own indications, are the anæsthetics of choice and that straight ether has only a limited field which will get less as time goes on.

# THE PRESENT STATUS OF ANOCIATION\*

A CRITICAL REVIEW

BY GEORGE W. CRILE, M.D.

OF CLEVELAND, OHIO

It is approximately seventeen years since the combination of anæsthetics and the development of the special operative management, which together we term "anociation," was first proposed, on the basis of the findings in researches as to the cause of surgical shock, which had at that time already been in progress for approximately fifteen years. During these seventeen years the researches have continued and operative methods and operative management have been modified, but the fundamental principle upon which the original conception was based has remained unchanged. We still believe that the minimizing of post-operative morbidity and the reduction of operative mortality demand the protection of the patient as a whole from the deleterious psychic, as well as traumatic effects of the operation. We still believe that each case must be strictly individualized and that no one can say in advance that this or that combination of methods will be applicable to every case.

In our original conception, we centred our attention on the brain and central nervous system as the parts of the organism which primarily required protection if the energy of the body was to be conserved. With the central nervous system we have now linked the liver in an indissoluble union of activity and of function and our efforts are directed to conservation of the liver as well as of the central nervous system in the management of our patients.

Seventeen years ago we believed that in nitrous oxid oxygen we had the inhalation anæsthetic, the use of which combined with local anæsthesia, provided the utmost protection to the cells of the central nervous system, as contrasted with the deleterious effects of the lipoid solvent anæsthetics. We still believe in nitrous oxid oxygen as the inhalation anæsthetic of choice; but we now rarely induce more than the stage of analgesia. Paradoxical as it may seem, the more serious the risk the less the amount of inhalation anæsthetic that is administered.

In the early days of the application of the principle of anociation we laid stress upon the importance of transporting timorous patients—in particular patients with hyperthyroidism, to the operating room under narcosis with morphin and scopolamin. A little later, still further to minimize the psychic effect of the journey from the patient's room to the operating room, the patient was anæsthetized in his room and conveyed under anæsthesia to the operating room. To-day we bring the operating room to the patient,

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\* Read before the American Surgical Association, May 13, 1927.

that is, the operation is performed in the patient's room without moving the patient from his own bed.

We formerly advocated the use of hot packs and the introduction of hot water to the abdominal cavity upon the completion of an abdominal operation in order that an optimum temperature might be conserved. We now more efficiently and adequately provide such an optimum temperature—of the liver in particular—by the application of diathermy before, during, and after the operation. In cases in which the abdominal viscera must be widely exposed, this measure of itself alone has doubtless saved lives and markedly diminished post-operative morbidity.

Before the war, and especially after we had observed in France the beneficial effects upon wounded soldiers of exposure to sun and electric light, we advocated the light treatment in certain cases. We have extended this principle by utilizing the energy of the sun as reproduced by the quartz lamp and apply this therapeutic measure in certain cases. This is of particular value in cases of patients exhausted by wasting disease and in the preparation and post-operative care of aged patients in whom, by diathermy and the use of the quartz lamp, the danger of post-operative pneumonia is minimized.

We have secured increasing evidence during these years that the circulation of energy is like the circulation of blood, and that therefore the organ or organs which govern the circulation of energy should be protected and stimulated just as the organ which governs the circulation of blood—the heart—is protected and stimulated by digitalization. We have therefore made it our prime aim to assure the circulation of energy by protecting and promoting the activity of the two dominant organs, the brain and the liver.

We have had impressed upon us increasingly during these years the importance of meeting the emergency *in advance*, that is, we have learned to apply the principle of prophylaxis to surgical practice. To this end protective measures are applied in advance of the possible emergencies during the pre-operative period—the heart, kidneys, and the general morale of the patient being brought to the highest possible degree of efficiency before the operation is performed. In no case do we wait until a vital emergency has developed, provided the emergency is one which we know by experience or by analogy may develop in any group of cases. We still place our principal reliance upon maintaining the internal respiration of the cells by assuring an abundance of their fundamental requirements, namely, water and oxygen. The supply of the former is assured by urging water through every route, in particular by its administration by hypodermoclysis—the quickest route whereby it may reach the cells; the supply of the second is assured by securing an optimum circulation of the oxygen-carrier—blood, by the transfusion of blood and by strengthening and protecting the myocardium by digitalis. An optimum supply of water, an optimum supply of oxygen, an optimum temperature, and optimum rest of the organism as a whole and in particular

of the brain and the liver, are still our principal conservative and restorative agents.

It may be well to review briefly in a little more detail the methods which are employed in those conditions which are generally conceded to be "bad risks"—acute hyperthyroidism, ulcer or carcinoma of the stomach, diseases of the gall-bladder, especially those associated with jaundice, peritonitis, carcinoma of the colon and rectum, diabetic gangrene. Whichever of these conditions may be present in the individual case, the following fundamental measures are employed: Two thousand c.c. of normal saline solution is given by hypodermoclysis— $1/32$  per cent. of novocain being added to this solution in accordance with Bartlett's method, to minimize discomfort. This is given once or twice a day together with  $1/6$  of a grain of morphin. To strengthen the myocardium, from four to six doses of digitalis—2 c.c. each—are given every four hours, these being followed by 20 minims twice a day. If anæmia or cachexia is present a transfusion of about 500 c.c. of blood is given and repeated if necessary. In every case the patient's blood is grouped upon his admission to the hospital in order that a donor may be at hand when needed. This is done in every case, whether or not the patient is classed as a bad risk, in order that there may be no delay should an entirely unexpected emergency arise.

If the heart is implicated to the extent that œdema or anasarca is present, especially in cases of hyperthyroidism, ammonium chlorid, 15 gr. four times a day for two days, is given followed by novasurol given intravenously in doses of from  $1/2$  to 1 c.c. every three or four days. This last measure has proved of such value that in many cases of hyperthyroidism, in which upon the admission to the hospital an operation seemed to be entirely contra-indicated because of the condition of the heart, the ligation can now be eliminated and a partial resection can be made the primary operation. This result, however, is due in part, possibly primarily, to the use of Lugol's solution which is given in doses of 15 minims, three times a day, the operation being performed when the maximum effect of the Lugol's solution is reached, which is usually in about ten days.

In every case, whether it be an operation on the thyroid gland or within the abdomen, the operation is arrested at any moment at which the condition of the patient may indicate that further procedures can be but poorly borne. It is far better to arrest the operation and delay its completion until physiological balance is established than to push the organism so far that recovery will be delayed, even if life itself is not lost. In general, even if no preliminary ligation is performed, the lobectomies are separated by periods of twenty-four hours, the wound being packed open with gauze impregnated with a 1 to 5220 solution of flavine. By this means the surgeon begins his work on the following day exactly where it was discontinued the day before. Rest is assured during both the pre-operative and the post-operative periods by the administration of from  $1/2$  to 3 gr. of luminal, which is given in

preference to other narcotics or hypnotics, although morphin is used as indicated excepting in any case in which jaundice is present.

In cases of carcinoma of the stomach a resection with a wide excision of the growth is indicated. Here, as in operations upon the thyroid gland in cases of acute hyperthyroidism, a divided operation suffices to carry through many patients in whom the prognosis appears to be hopeless.

In cases of gall-bladder disease special precautions are taken to protect the liver against damage by the operation or by exposure. The fact that the liver cells have already been damaged, particularly in cases in which jaundice is present, is always borne in mind. The prevention of hemorrhage and the establishment of adequate drainage are the prime requisites in the protection of the liver. After operations upon the gall-bladder, drainage is established through the most dependent area, *i.e.*, through Morrison's pouch, the patient being kept in Fowler's position. In cases of peritonitis we still utilize the old Alonzo Clark method by administering morphin in sufficient amount to keep the respiratory rate at from 16 to 18 per minute. Dependent drainage is established and the patient is kept in Fowler's position. Here also the operation is interrupted if the condition of the patient demands it, no attempt being made to remove the source of infection, whether it be the appendix or some other focus, until the optimum moment for the operation has been reached. In cases of carcinoma of the large intestine or colon, obstruction is first relieved by means of a colostomy and again the major operation is postponed until physiological balance has been established.

In cases of patients with diabetes we are now able to apply the natural remedy, insulin, and by its aid to carry through operative procedures which formerly would have been contraindicated. This applies not only to cases of diabetic gangrene, but to any other operation which may be indicated as necessary in a diabetic patient. These patients are placed under the immediate care of Dr. Henry John, the head of our Diabetic Department, who indicates when an operation is compatible with the diabetic condition. Since the advent of insulin no deaths which could be attributed to diabetes have followed operation.

To reiterate briefly: Hypodermoclysis, an adequate supply of oxygen secured by digitalization of the heart and by the transfusion of blood; an optimum temperature secured by means of diathermy; additional energy induced by the quartz lamp; minimum trauma; divided operation; general anæsthesia carried only to the stage of analgesia, with prime reliance upon regional anæsthesia; feather-edge bloodless dissection; dependent drainage; the application of all known methods for promoting the optimum function of the heart and kidneys, environmental control; adequate sleep and rest—all these together constitute the armamentarium which we have designated by the term "anociation".

# ETHYLENE AS AN ANÆSTHETIC FOR GENERAL SURGERY\*

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AND

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WE HAVE been using ethylene extensively as a general anæsthetic for a period of about three and a half years and during this period have employed it in 11,607 cases. This appears to be a number sufficient to warrant an attempt to draw approximate conclusions in regard to its value. As a candidate for acceptance in this field, it must be compared with ether and chloroform, on the one hand, and nitrous oxide and oxygen on the other. It is not, we think, necessary to discuss its relation to local, regional, spinal or sacral anæsthesia since the indications for these methods must stand upon different bases. During this period all of the patients have been anæsthetized by trained women anæsthetists under the supervision of our Chief Anæsthetist, Miss Laura M. Davis. This is the same group which has been administering anæsthetics for us over a considerable period and it therefore makes comparison with other anæsthetics satisfactory. Our usual custom is to give morphine from a sixth to a quarter of a grain and atropin one hundred fiftieth from fifteen minutes to half an hour before operation. In the number of cases above referred to ether has been sometimes used mixed with ethylene and in a relatively small proportion, has been the chief anæsthetic. In about 70 per cent. of these cases, ethylene alone was used. In about 27 per cent., ether vapor was given with ethylene, and in about 3 per cent. ethylene was used only for induction and the balance of the operation was done under ether administered by the drop method. These proportions seem to agree fairly accurately with those reported by other observers of considerable experience.

*Induction.*—The stage of induction is rapid, practically the same as that with nitrous oxide but in contradistinction to the latter, the color remains good throughout. We have noted no greater tendency to initial nausea.

*Apparent Effect on the Patient.*—Throughout the operation the appearance of the patient has been good. There is a striking absence of the occasional cyanosis relatively often seen with nitrous oxide and oxygen, this being due to the fact that larger amounts of oxygen can be given and yet obtain full anæsthesia. It should be noted in this connection that the danger associated with the administration of nitrous oxide appears to exist only during the presence of cyanosis and it has been generally believed that if cyanosis could have been entirely eliminated in the administration of the latter gas its

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undoubted danger would have been greatly diminished. It, therefore, appears that the elimination of cyanosis under the use of ethylene contributes considerably to the probability of its proving to be a safe anæsthetic. The absence of sweating has been notable particularly as compared with ether and to a somewhat lesser extent with nitrous oxide. Anæsthetic recovery is prompt, practically the same as that with nitrous oxide. To some extent this prompt recovery from anæsthesia induced by gas is not altogether desirable since it has the effect of subjecting the patient to the full effect of the pain consequent upon the surgical trauma which was considerably mitigated by the slow recovery from anæsthesia with ether or chloroform. Where gaseous anæsthetics are used we have found it necessary to administer morphia more promptly after operation and in a somewhat larger per cent. of cases.

*Nausea and Vomiting.*—The incidence of nausea and vomiting has been substantially like that of our previous experience with nitrous oxide. It may occur during the stage of induction, may occur during anæsthesia if it become unduly light, and is common during the brief period of anæsthetic recovery. The prolonged nausea and vomiting relatively common after the administration of ether or chloroform is importantly less with ethylene. The proportion of cases in which nausea and vomiting persisted for hours and occasionally for days is small and we have been unable to separate it from the same symptoms related primarily to the operation and not particularly to the anæsthesia. We have not thought that ethylene had any advantage in this particular over nitrous oxide, but are quite clear that it has a very distinct advantage over ether or chloroform.

*Muscular Relaxation.*—One of the important purposes of anæsthesia is to give muscular relaxation and the extent to which this is achieved by any general anæsthetic is of some importance. The most complete relaxation is probably obtained by chloroform but entirely satisfactory results are obtained with ether. In our experience it was never possible to get the highest degrees of relaxation particularly in abdominal operations under the use of nitrous oxide and oxygen. Our experience with ethylene has been that it occupies a position somewhere nearly half-way between ether and nitrous oxide in this regard. There have been a considerable group of patients chiefly with operations in the upper abdomen, often upon the stomach or gall-bladder, in which the requisite degree of relaxation could not be obtained with ethylene or even with reasonable admixture of ether vapor. It is chiefly this group that makes up the three per cent. of cases in which ether was administered practically exclusively. Muscular relaxation is relatively more important in abdominal surgery and our experience with surgery other than that of the abdomen has been that ethylene was wholly satisfactory from the point of view of relaxation. In strong muscular individuals, and particularly when dealing with lesions deeply placed in the upper quadrant of the abdomen, ethylene has not in our hands been a wholly satisfactory anæsthetic and we do not expect to employ it in these cases as a routine method.

*The Effect on Blood-pressure.*—One of the questions properly asked of



a candidate for credit among anæsthetics is the effect upon blood-pressure. A study of a moderate number of our cases appears to show that there is very commonly an initial rise of blood-pressure amounting on the average to about 17 per cent. In our observations the extremes varied from 0 to 55 per cent., the latter figure being rarely reached. This rise occurs promptly and falls off rapidly during the subsequent half hour, returning to normal at about that time. It has appeared to us that there was somewhat more bleeding during the early stages of the operation than occurred with ether, though not importantly different from that seen with nitrous oxide. It is not impossible that this observation is related to the initial rise in blood-pressure and may constitute a relative contra-indication in certain groups of cases. For instance, a dry field is of enormous importance in brain surgery and in this field we have entirely abandoned the use of ethylene and in fact, rarely use any general anæsthetic. Most of these cases have, during the above period, been carried on under local anæsthesia, and where a general anæsthetic has been employed, ether has been selected.

This apparent effect upon blood-pressure has some bearing upon the value of this anæsthetic in the presence of shock. It was, we think, satisfactorily shown some years ago, though confirmed by the experience during the war, that nitrous oxide and oxygen was altogether superior to ether or chloroform as an anæsthetic under these conditions. This was partly due to their effect upon blood-pressure and also to their effect upon the alkali reserve. In our experience, ethylene has been quite the equal of nitrous oxide for patients in shock and we think, therefore, that it may be accepted as preferable to ether or chloroform under these conditions.

*Effect on Kidney Function.*—There has been relatively little study of the effect of general anæsthetics upon kidney function. In 1915, one of us (H. C.), in conjunction with Richard Miller, made a fairly careful study of the effect of ether upon kidney function as tested with phthalein. My junior colleague, C. E. McDermid, has carried out a similar study for ethylene based upon examination of one hundred eighty-four cases. (See McDermid's "A Comparative Study of the Effect of Ethylene and Ether Anæsthesia upon Kidney Function as Shown by the Phenolsulphonephthalein Test"—unpublished communication). Without going too much into the details of this study his results appear to show that ethylene has less effect in diminishing kidney function than ether. Thus in 335 cases of operations of more than thirty minutes' duration, Miller found an average diminution of output of 19 per cent. while McDermid, in 106 cases, found an average diminution of 14 per cent. In operations lasting from one to two hours Miller found an average diminution in 95 cases in which ether was administered, of 23 per cent. while McDermid, in 61 cases of ethylene anæsthesia, found a diminution of 14 per cent. It is, we think, safe to conclude that ethylene has a less deleterious effect upon kidney function than ether. We are by no means clear that the relatively slight diminutions observed by McDermid can be credited to the anæsthetic at all and incline to the view that quite similar

results would be obtained in a study of patients in whom the same operations were carried out under regional or local anæsthesia. In other words, we suspect that it is the operation rather than the anæsthesia which is accountable for the changes.

*Pulmonary Complications.*—One of the most valid charges against ether has been its liability to cause irritation of the respiratory tract, occasionally leading to grave post-operative complications and also to light up latent tuberculous lesions which were satisfactorily quiescent. In this regard it has been quite certain that nitrous oxide was altogether superior to ether and if the claim of ethylene to displace nitrous oxide is to be substantiated, it must show an equally satisfactory result. Our experience in the considerable group of cases has been that ethylene is quite as satisfactory as nitrous oxide in this particular. We have no record of any case of post-operative pneumonia where ethylene alone was employed. In about 4 per cent. of the cases in which ether was used with ethylene, various degrees of bronchial irritation and bronchitis have occurred. There have been three cases of frank post-operative pneumonia also in this group. These figures are based upon the assumption that respiratory complications consequent upon the anæsthetic will show evidence of their presence within five days.

*Danger of Ignition or Explosion.*—The most serious question which confronts those who would use ethylene as a general anæsthetic is in regard to its inflammability or explosibility. This question has been much discussed and we have little to add except a statement of our own experience. We can contribute nothing to the facts already presented in regard to the dangers of explosion since no case has occurred in the above-mentioned group. During the same period there has been one explosion of an anæsthetic apparatus not in use but in this case the exploding mixture was ether. We think there can be no discussion in regard to the absolute necessity of avoiding naked flames or sparks in or near the operating room. This prohibition, we think, is absolute, and if gas flames, electric sparks or cigarette smoking members of the staff cannot be excluded, the use of this anæsthetic is contra-indicated. This property also vetoes its use where the cautery, the endotherm or any form of electrical current involving a spark is to be used. It seems quite certain that ethylene is not explosive in the mixtures used for anæsthesia. It is the lean mixtures below those satisfactory for anæsthesia that are explosive. There has been much discussion of the importance of static sparks in the causation of accidents. In regard to this we can only say that we have not found it necessary to use any of the elaborate methods for grounding the apparatus and the anæsthetists and have relied upon a very high degree of cleanliness of the apparatus to guard against such accidents. At our suggestion, an investigation of the explosive possibilities was undertaken by Professor C. C. Meloche of the Department of Chemistry. This investigation is still incomplete and no formal report has been made.

At the present time Professor Meloche is still investigating the possible explosive qualities of cleanings obtained from various parts of the apparatus.

This material, which was collected for him by Miss Davis, is described as a "greasy, highly carbonaceous, copper containing material." This he separated from the oil by use of a centrifuge and washing with ether. It was then dried over an electric oven at 100° for one hour and experiments were then begun on its explosive qualities. Unfortunately the experimenter allowed the heat of the apparatus grossly to exceed that which was contemplated and a violent explosion took place, wrecking the apparatus though fortunately doing little damage to the experimenter. This apparently somewhat discouraged the investigator and the problem is still under discussion.

While of course no conclusions would be warranted from these observations, it is at least suggested that meticulous care in cleaning all parts of the apparatus is of first-class importance. We shall hope to make further report on this subject later.

#### SUMMARY

Our experience with ethylene as an anæsthetic appears to us to justify the following conclusions:

As an anæsthetic it has all of the advantages of nitrous oxide and oxygen and also gives greater relaxation and avoids objectionable cyanosis. It appears to be remarkably free from danger except that possibly resulting from explosions. It will not give complete muscular relaxation particularly for operations in the upper abdomen, and if this is required, it must be combined with local or regional anæsthesia or another anæsthetic selected. In our practice it has practically pushed nitrous oxide from the field and will, we believe, for ordinary surgical practice, supersede it. It is not an anæsthetic which can be employed except where trained anæsthetists are on hand and a rather cumbersome apparatus is available. It is not likely, therefore, to supersede ether or chloroform for use outside of hospitals, but for general hospital practice, it has outstanding advantages.

## BLOOD CHANGES UNDER ETHYLENE ANÆSTHESIA\*

BY HUGH H. TROUT, M.D.

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A FEW months before the publication of the preliminary report on ethylene by Luckhardt and Carter,<sup>1</sup> our attention was called by Dr. Dean Lewis to the lowered rate of increase of blood sugar in dogs when using this then new anæsthetic.

Banting gave the first injection of insulin on January 10, 1922, but, its general employment did not take place for several years later. This was due both to the reluctance with which the medical profession accepted it, as well as to the difficulty of obtaining a standardized product. During this period, after the introduction of ethylene, and before the universal acceptance of insulin, we had nine cases of diabetes on whom ethylene was employed for surgical complications. In seven of these cases there was a temporary rise of about 50 per cent. in the blood sugar, while, with two, there was a 10 per cent. decrease. The blood sugar in all nine cases returned in twenty-four hours to what it had been before operation. We had no comparison of a blood sugar study of a similar series of cases operated on with ether as the anæsthetic. However, all nine of these cases reacted more satisfactorily as regards their diabetes than had been our experience when using ether in similar cases.

Of course, the general employment of insulin has made any anæsthetic now comparatively safe as far as blood sugar is concerned. However, if one anæsthetic produces fewer and less marked changes in the blood chemistry than another, then such an agent has a definite field in surgery, not only in the diabetic but also in any badly handicapped patient—not to mention the lessening of discomfort in the post-operative recovery of the average patient.

No study was made of the acid-base balance and none of the CO<sub>2</sub> combining power, for many reports have already been made on these changes with the various anæsthetics. Nor have we made any studies of the effects of anæsthetics on the blood-cells, for, there are so many factors, such as infection, secondary anæmia, etc., entering in this field, that it would be impossible to properly estimate such results. In passing, it is worthy of note that an increase of the leucocyte count can apparently be due to a diabetic acidosis independent of any infection.

This fact is proven by the number of such cases reported, and by two cases admitted to Jefferson Hospital, Roanoke, Virginia, on whom insulin, for one reason or another, had been omitted in a diabetic patient, with not only the resulting coma, but also with the development of a very high leucocyte count. With the giving of insulin, the coma cleared up, and the

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leucocyte count returned very promptly to normal. Of course, the clinical importance of this observation is too obvious to more than mention, especially if one recalls the abdominal pains sometimes associated with diabetic acidosis.

A few months ago we started making a comparative study of the blood of patients who were given ethylene-oxygen anæsthesia in comparison with the blood of patients on whom other anæsthetics were employed. The major part of this comparison has been with ether, though ether in combination with ethylene; chloroform; nitrous oxide-oxygen and regional (sacral) anæsthesia have been compared in a few cases.

The changes in (a) blood sugar, (b) bleeding time, (c) coagulation time and (d) native complement have been studied and ethylene-oxygen compared with the other anæsthetics above mentioned.

These changes in the blood were studied not only in patients but a comparison was also made in dogs.

In all the patients there were three specimens of blood obtained from each case. The first specimen being obtained several hours before the anæsthetic started and without any breakfast. All patients, however, had morphia, grain  $\frac{1}{8}$  with atropine grain  $\frac{1}{150}$  about fifteen minutes before anæsthetic started. The second specimen procured just before the anæsthetic was discontinued. The third specimen acquired twenty-four hours after cessation of the anæsthetic.

In the ethylene group there were 100 patients who were given nothing except ethylene-oxygen. The average length of time for this group was thirty-six minutes, while the average increased percentage of blood sugar was 29 per cent. for first post-operative specimen, or .8 per cent. per minute.

With fifty-three ether cases the average length of time was forty-eight minutes, while the average increased percentage of blood sugar for the first post-operative specimen was 73 per cent. or 1.51 per cent. per minute.

From this it is seen ether increased blood sugar 46 per cent. more than ethylene per minute for the first post-operative specimen. In twenty-four hours, the blood sugar in both series returned to practically the same as it was pre-operatively.

With dogs this increase of blood sugar was even more marked with those animals taking ether. Briefly the average increase percentage of the first post-anæsthetic specimen was 185 per cent. greater with ether than with ethylene.

In 1924, Leake and Hertzman<sup>2</sup> experimenting with dogs, "found the changes in the blood sugar and alkali reserve in dogs under ethylene-oxygen anæsthesia much less in rate and degree than with either chloroform or ether."

From this comparison between the results on dogs and on human beings, it is seen this is but another illustration of the well-known fact too much reliance cannot be placed on animal experimentation. However, ether increased the blood sugar more than ethylene in both patients and dogs.

There is a rather general impression found amongst surgeons that both the coagulation and bleeding time is slightly, but temporarily, increased by

ethylene. Luckhardt and Lewis<sup>3</sup> thought *perhaps* oozing was a little more marked with ethylene than with other anæsthetics. In our series in both human beings and dogs this has not been found to be true. In fact, the average increase in patients per cent. per minute of ether over ethylene, as regards coagulation time, is 125 per cent. With dogs this was less marked, for, the average increase per cent. per minute of ether over ethylene was 110.4 per cent.

With bleeding time the percentage of ethylene decrease per minute over ether is .0014 per cent. in patients; while with dogs it was 3.8 per cent.

Straus and Rubin<sup>4</sup> concluded in their recent article on this subject:

"1. In twenty-five patients we found a definite decrease in the coagulation time during and shortly following the administration of ethylene anæsthesia.

"2. This decrease was short-lived. In most instances within twenty-four hours there was a return of the coagulation time to that noted before the introduction of narcosis.

"3. The bleeding time was also decreased."

Allen and Murray<sup>5</sup> do not believe from their observations of 2750 cases of ethylene anæsthesia, that the bleeding time is increased, though, they did not report any definite estimates. J. S. Horsley, Jr.,<sup>6</sup> in twenty-five consecutive ethylene anæsthesia cases made estimates of the coagulation time, before operation, at the close of operation, and seventy-two hours following operation, and came to the conclusion that coagulation time was not prolonged.

It is perfectly possible the cutaneous oozing which some surgeons believe is occasionally present with ethylene, might be due to the momentary cyanosis produced by the anæsthetist attempting to obtain relaxation just as the operation starts.

Deductions made from a study of the so-called native complement indicates there is less disturbance to this indicator of resistance with ether than with ethylene. This holds true both in the human being as well as dogs.

A detailed laboratory report follows this summary, though, of course, even in such a report many tables are necessarily omitted.

The following is a report of experimental work done by the laboratory staff of the Jefferson Hospital in 167 cases, to determine the effect of ether, ethylene and in a few instances other anæsthetics, on blood sugar, coagulation time, bleeding time and native complement.

The technic of Folin and Wu for blood sugars was used. This consisted in using the protein-free blood filtrate, alkaline copper solution, boiling six minutes, cooling, the addition of phosphomolybdic acid and distilled water, after which estimations are made in the Kober Colorimeter.

For coagulation time Howell's method was employed (4 to 5 c.c. of blood are withdrawn from a vein of the forearm, expelled at once into a clean glass tube and slightly tilted.) Coagulation time is that period elapsing between the time of withdrawal and the time when the clot is sufficiently formed to allow the tube to be inverted.

For bleeding time, Duke's method was used. This consists in cleaning

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the finger with alcohol and then with a dry, sterile sponge. The finger is then punctured with a lancet and the time taken after the first drop is wiped away until bleeding ceases. Each drop as formed is absorbed with a piece of filter paper.

Complement, one of the indicators of resistance, was also studied. Titrations were made on each serum under the same conditions and at the same time. We began with .01 c.c. of serum, increasing to .08 c.c., or in some cases to .1 c.c. 5 c.c. of physiological salt solution, followed by the same amount of a 1 per cent. cell suspension were then added. The latter had been previously sensitized with an anti-sheep hæmolytic amboceptor. Normally there should be sufficient complement in .01 to .02 c.c. of serum to produce a complete hæmolysis of the sheep cells.

Patients were grouped according to anæsthetic, operation and the time in which anæsthesia was employed.

There were 100 patients having ethylene, 53 having ether, 8 regional, 1 N<sub>2</sub>O and ether, 2 chloroform, 1 N<sub>2</sub>O and ethylene.

The following is a summary of our findings, details of which will be found grouped separately and of which a second report is being made:

### CASES IN WHICH ETHER AND ETHYLENE ANÆSTHETICS WERE EMPLOYED AVERAGED AS FOLLOWS:

Blood sugar	Ether	Ethylene
Average time .....	48 minutes	36 minutes
Average pre-operative .....	129 mgms.	140 mgms.
		Diabetics included
Average first post-operative .....	217 mgms.	182 mgms.
Average second post-operative .....	130 mgms.	142 mgms.
Average increase, first post-operative .....	88 mgms.	38 mgms.
Average percentage increase, first post-operative.	73%	29%
Average increase, second post-operative .....	1 mgm.	2 mgms.
Average percentage increase, second post-operative .....	.8%	1.4%
Average increase per minute, first post-operative.	1.51%	.8%
Average percentage increase of ether over ethylene of .....		.71 or 46%

It may readily be seen that the second post-operative estimations were practically the same as the pre-operative findings, neither anæsthetic appearing to alter the blood sugar to any marked extent twenty-four hours after operation.

Coagulation time	Ether	Ethylene
Average time .....	48 minutes	36 minutes
First post-operative, total increase .....	4½ minutes	5 minutes
First post-operative, average increase .....	.08 minutes	.05 minutes
First post-operative, average increase per minute.....	.0016	.0013
First post-operative, average increase per minute in seconds .....	.09	.04

First post-operative increase, coagulation time, per minute of ether over ethylene is thus 125 per cent.

# HUGH H. TROUT

Coagulation time	Ether	Ethylene
Second post-operative, total increase .....	11½ minutes	20 minutes
Second post-operative, average increase .....	.21 minutes	.2 minutes
Second post-operative, average increase per minute ..	.0043	.0055
Second post-operative, average increase per minute in seconds .....	.25 seconds	.33 seconds

Therefore second post-operative increase of coagulation time in ethylene over ether is 32 per cent.

Bleeding time	Ether	Ethylene
Average time .....	48 minutes	36 minutes
Total increase, 1st, post-operative .....	5.5 minutes	7.75 minutes
Average increase, 1st, post-operative .....	.103 minutes	.1175 minutes
Average increase per minute, first post-operative....	.0021	.0021
Average increase per minute, first post-operative....	.126 seconds	.126 seconds
Average percentage, increase per minute, first post-operative .....	.463%	.405%

Therefore there is a first post-operative average percentage increase per minute of ether over ethylene of .0014 per cent.

It may thus be seen that there was no practical increase from the standpoint of bleeding time in the first post-operative findings.

Bleeding time	Ether %	Ethylene %
Increase second post-operative .....	70	6.75
Average percentage increase, second post-operative.....	1.32	6.75
Average percentage increase per minute .....	.027	.187

Therefore, it may be seen from the above that there was a percentage increase in bleeding time of .85 of 1 per cent. per minute of ethylene over ether.

*Complement.*—For the first post-operative there was an average increase per minute under ethylene of .834 per cent. Ether showed a percentage average increase per minute of .7 of 1 per cent. It may be seen, therefore, that there is practically no difference in complement, though the balance of .1 of 1 per cent. is slightly in favor of ether.

In the second post-operative complements the average increase per cent. for ethylene per minute was .423 per cent., while for ether it is .135.

False conclusions from the above might be drawn that ether was better from the standpoint of complement by 21 per cent., though the type of operation, necessary shock following same, etc., plays a great part in the above percentages.

A similar study to show the comparative values of ethylene and ether was made on each of ten adult dogs. The animals were first anesthetized with ethylene, held in this state of anesthesia for twenty minutes, after which they were allowed to revive. Blood sugars, coagulation times and bleeding times were taken under identically the same conditions as in the first portion of this report concerning the human patients. The same animals were then allowed to rest for a week, at the end of which time they were again anesthetized for a like period of time with ether anesthetic and the same observations were made.

Blood sugar	Ether	Ethylene
Average time .....	20 minutes	20 minutes
Average pre-anæsthetic .....	131 mgms.	110 mgms.
Average first post-anæsthetic .....	236 mgms.	141 mgms.
Average increase, first post-anæsthetic .....	105 mgms.	31 mgms.
Average increase percentage first post-anæsthetic.....	80%	28%

The average first post-anæsthetic increase of ether over ethylene was 21 mgms., average increase percentage first post-anæsthetic, ether over ethylene, 185 per cent.



# BLOOD CHANGES UNDER ETHYLENE ANÆSTHESIA

Blood sugar	Ether	Ethylene
Average second post-anæsthetic .....	143 mgms.	95 mgms.
		Decrease
Average increase second post-anæsthetic .....	12 mgms.	15.5 mgms.
		Decrease
Average increase per minute, second post-anæsthetic....	.655	.775 mgms.
		Decrease
Average percentage increase per minute, second post-anæsthetic .....	.91%	.7%

Therefore the average decrease of ethylene percentage over ether percentage is 1.61 per cent. The average decrease of ethylene over ether per minute is .8 per cent., and the average per cent. decrease of ethylene over ether is 23 per cent.

Coagulation time	Ether	Ethylene
Average pre-anæsthetic .....	1.15 minutes	.95 minutes
Average first post-anæsthetic .....	1.7 minutes	.90 minutes
Average second post-anæsthetic .....	1.37 minutes	.8 minutes
Average percentage increase, first post-anæsthetic..	48%	Decrease 5%
Average increase per minute, first post-anæsthetic.	2.4%	Decrease .25%
Average percentage increase, second post-anæsthetic .....	1.9%	Decrease 15%
Average percentage increase per minute.....	.95%	Decrease .75%

The ether average *percentage* increase per minute over ethylene average decrease percentage per minute is 2.65 per cent., and the average increase per cent. per minute ether over ethylene is 110.4 per cent.

In the second post-anæsthetic, the ether average increase per minute over ethylene is 1.7 per cent. The *percentage* increase, therefore, of ether over ethylene per minute is 178 per cent.

Bleeding time	Ether	Ethylene
Average pre-anæsthetic .....	1.27 minutes	1.2 minutes
Average first post-anæsthetic .....	.925 minutes	.6 minutes
Average second post-anæsthetic .....	.110 minutes	1 minute
Average percentage decrease, first post-anæsthetic....	27%	48%
Average percentage decrease, per minute, first post-anæsthetic. ....	1.3%	2.4%
Average percentage decrease, second post-anæsthetic..	13%	16%
Average percentage decrease per minute, second post-anæsthetic .....	6.5%	.8%

The decrease per cent. ethylene was 21 per cent. The ethylene decrease per cent. per minute was 1.05 per cent. The percentage of ethylene decrease over ether decrease is 77 per cent. and the percentage of ethylene decrease per minute over ether decrease is 3.8 per cent.

Complement	Ether	Ethylene
Average time .....	20 minutes	20 minutes
Average pre-anæsthetic .....	.047	.042
Average first post-anæsthetic .....	.049	.047
Average second post-anæsthetic .....	.048	.048
Average percentage increase, first post-anæsthetic .....	.42%	1.19%
Average percentage increase, first post-anæsthetic, per minute .....	.021%	.059%
Average percentage increase, second post-anæsthetic ....	.28%	1.428%
Average percentage increase, second post-anæsthetic per minute .....	.014%	.0714%

Average per cent. increase of first post-anæsthetic, ethylene over ether, 183 per cent. Average increase second post-anæsthetic, ethylene percentage over ether percentage, .057 per cent. Average percentage increase, second post-anæsthetic, ethylene over ether, 407 per cent.

The following is a summary of the average increases and decreases of the various other anæsthetics which were used in our human cases, as compared to ethylene. The tests were run in identically the same manner and under the same conditions as those mentioned under ether and ethylene alone.

# ETHYLENE AND ETHER

## Blood sugar.

First post-operative-average increase per cent. per minute.....	.5%
Second post-operative-average increase per cent. per minute.....	.7%
First post-operative-average increase per cent. of ethylene over ethylene and ether .....	.3%
Second post-operative-average decrease per cent. of ethylene over ethylene and ether .....	.68%

## Coagulation time.

First post-operative-average decrease per minute .....	.05 or .06%
Second post-operative-average increase per minute .....	.001 or .03%
First post-operative-average increase ethylene over ethylene and ether .....	.0513 or 590%
Second post-operative-average increase ethylene over ethylene and ether .....	.004 or 400%

## Bleeding time.

First post-operative-average increase per minute .....	.001 or .3%
Second post-operative-average decrease per minute .....	.001 or .3%
First post-operative-average per cent. increase per minute, ethylene over ethylene and ether .....	.15 or 37%
Second post-operative-average per cent. increased per minute, ethylene over ethylene and ether .....	.4 or 213%

## Complement.

First post-operative-average increase per minute .....	.33%
Second post-operative-average increase per minute .....	.01%
First post-operative-average per cent. increase per minute of ethylene and ether over ethylene of .....	.271%
Second post-operative-average per cent. increase per minute of ethylene over ethylene and ether of .....	.0614%

# REGIONAL

## Blood sugar.

First post-operative-average increase per minute .....	1.04 mg. or 173%
Second post-operative-average increase per minute .....	.16 or .11%
First post-operative-average increase per minute, ethylene over regional .....	.01 or .07%
Second post-operative-average increase per minute, regional over ethylene .....	.105 or .72%

## Coagulation time.

First post-operative-total decrease .....	3.5 minutes or 74%
First post-operative total increase .....	2 minutes or 95%
First post-operative-total decrease .....	1.5 minutes, or increase total 21%

## BLOOD CHANGES UNDER ETHYLENE ANÆSTHESIA

First post-operative-average decrease per minute	.044 or inc. .026%
Second post-operative-average increase per minute .....	.0045 or 49%
First post-operative-average decrease per cent. per minute, regional over ethylene .....	.074%
Second post-operative-average decrease per cent. per minute, regional over ethylene.....	1.02%

### *Bleeding time.*

First post-operative-average increase per minute .....	none
Second post-operative-average increase per minute .....	none
First post-operative-average decrease per minute, regional over ethylene ....	.405%
Second post-operative-average decrease per minute, regional over ethylene ..	.18%

### *Complement.*

First post-operative-average increase per minute .....	.0023 or 1.672% (no decrease)
Second post-operative-average increase per minute .....	.00029 or 2.65%
First post-operative-average increase per minute, regional over ethylene .....	.838%
Second post-operative-average increase per minute, regional over ethylene .....	2.227%

## SUMMARY

Finally we believe ethylene-oxygen anæsthesia produces: (a) Less alteration of the percentage of blood sugar, no appreciable change in either; (b) the coagulation time, or (c) the bleeding time, and (d) only a slight disturbance of the native complement when compared with any other of the now commonly employed anæsthetics. However, the whole study of blood changes under any anæsthetic is apparently dependent on the amount of oxygen in the circulation therefore, the anæsthetic chosen for the individual case should be the one that gives less cyanosis with a comfortable relaxation and does this in that particular hospital where it is to be employed.

I am gratefully indebted to Dr. K. T. Redfield and his assistants for all the laboratory work, and to Dr. J. W. Sayre and Miss Florence Barnett for their assistance with the various anæsthetics.

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# ANÆSTHESIA IN GENITO-URINARY OPERATIONS\*

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A SPECIAL technic for securing the type of anæsthesia best suited for regional operations has developed together with the technic of the performance of such operations. In the field of genito-urinary surgery, in particular, it has been found that a general inhalation anæsthesia is not the anæsthetic method of choice, since in most cases there is either a functional impairment or some pathological condition of the kidney.

Since the discovery in 1900 by Kaplan that the sacral canal could be used for the production of anæsthesia, and the successful utilization of this method by Stoeckel in 1909, the use of sacral anæsthesia has been extensively advocated, for genito-urinary operations in particular, as has spinal anæsthesia since its first application by Corning in 1885. Each of these methods has its ardent advocates, advocates who in too many instances urge the use of one or the other of these measures as being adapted to practically every type of operation, especially in the pelvic region.

The prime purpose of this paper is to deprecate the application of any one method of anæsthesia to the exclusion of other methods, whatever the type of operation to be performed; and on the other hand, to propose that the anæsthetic method be strictly individualized, that is, that it be adapted in every case to the psychic and physical condition of the patient as well as to the anatomical possibilities of the case. Perhaps in no other group of cases is this need for strict individualization more emphatically needed, for the genito-urinary surgeon deals with every type of individual at every age, and because of the peculiar nature of diseases within the genito-urinary tract the psychic factor is usually prominent, if not predominant. The comparatively young man with stricture, the woman with persistent cystitis, and the old man with an enlarged prostate and resultant retention, each has a high degree of nervous irritability which must be recognized as a serious factor in any surgical procedure. The mere overcoming of pain caused by the trauma of local nerves, therefore, is not sufficient; such pain, in fact, might be far less harmful than psychic distress.

It follows that the principle of anoci-association should be applied in these, as in operations in which a combination of methods is more generally applied, such, for example, as operations for exophthalmic goitre, and operations on the stomach or gall-bladder, etc.; that is, in each individual case we should employ such a combination of anæsthetic and operative methods as will minimize both psychic and traumatic shock.

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In addition to the general objections to the lipid solvent anæsthetics, it should be borne in mind that, as we have already mentioned, inhalation anæsthetics have a special effect upon the kidneys. Albuminuria follows inhalation anæsthesia with ether in about one-fourth of the cases and casts are frequently found in the urine. Provided the kidneys are sound, the irritation produced by ether or chloroform usually disappears in a short time, but in patients in whom the kidneys are already diseased the effect of the inhalation anæsthesia may be sufficient to produce a fatal suppression of the urine or an intractible albuminuria. Moreover, as stated by Sollmann,<sup>1</sup> experimental studies have shown that the kidneys of old animals show greater histological and functional injury after anæsthesia with ether and chloroform than do those of younger animals, this often being the case even in animals in which the kidney function before operation appeared to be normal.

Sollmann has found that the functional capacity of the kidneys, as measured by the phenolsulphonephthalein test, is somewhat decreased by ether anæsthesia, this effect being in direct relation to the duration of the anæsthesia. It would appear, therefore, unnecessary even to try to offer any argument in favor of anæsthesia with ether in operations which affect the kidneys. In operations upon the bladder for carcinoma or in operations upon the prostate, when the vitality of the patient is usually diminished both by age and by urinary disturbances, inhalation anæsthetics are contraindicated because of their effects upon the cells of the central nervous system. As Crile's researches have shown, ether anæsthesia of itself alone contributes directly to the production of shock.

The choice, therefore, of anæsthetic methods in genito-urinary surgery must lie among nitrous oxide oxygen analgesia, ethylene gas, spinal anæsthesia, sacral anæsthesia, and local anæsthesia. In analgesia produced by nitrous oxide oxygen a sufficient degree of relaxation is rarely obtained. While nitrous oxide oxygen analgesia may be used as an adjuvant, some other method of anæsthesia is required, therefore, and our choice is further reduced to spinal, sacral or local anæsthesia.

Among the latter, according to my own experience, spinal anæsthesia is most hazardous because of its effect upon the blood-pressure. I know that my judgment in this regard is not in accord with that of many other operators. Rytina,<sup>2</sup> in particular, offers in favor of spinal anæsthesia a series of 73 prostatectomies with but one death and no permanent complications; only one operation in this series was performed in two stages. Although Rytina's judgment seems to be confirmed by that of other writers, nevertheless, for ourselves we place our chief reliance upon sacral block and local infiltration for suprapubic and scrotal operations, and upon regional nerve block, local infiltration, and nitrous oxide oxygen analgesia for operations upon the kidney.

In operations upon the kidney it should be borne in mind that although

the approach is through tissues which are not as fully endowed with afferent nerves as are the tissues of the anterior abdominal wall, nevertheless there are a sufficient number of nerve-endings in the skin and muscles to make their infiltration advisable. I have used local infiltration and a paravertebral block for nephrectomy in a number of cases, and the only case in which the patient complained of pain was one in which the kidney was inflamed and adherent to the peritoneum, so that the separation of the adhesions was very difficult.

In operations below the kidney, however, that is, on the bladder and the prostate, a sacral block is employed, the technic which we use being the same as that which has been carefully described by Hunt.<sup>3</sup> A one per cent. solution of novocain combined with 6 minims of a 1/1000 solution of adrenalin is injected through the sacrococcygeal membrane into the caudal canal, the insertion of the needle being preceded by progressive anæsthetization of the path to the caudal canal. Occasionally this is followed by injections through the second, third and fourth sacral foramina on each side. After these injections have been made, the patient is turned over and a complete regional block of the abdominal wall is made. The anæsthesia obtained by this method lasts for an hour or more, complete relaxation is secured, and the operation is painless.

If the operation is carried to the bladder, the wall of the bladder is infiltrated with a  $\frac{3}{4}$  per cent. solution of novocain. If the prostate is to be removed, then the novocain is infiltrated between the gland and the capsule, as this helps to separate the prostate from the capsule. Sacral anæsthesia, therefore, is of value in all operations upon the bladder and prostate—the removal of a diverticulum of the bladder, the removal of bladder stone, resection of the bladder and prostatectomy.

In all cases, however, and this is a point upon which we lay special stress, if the patient is at all apprehensive, the anæsthetist is prepared to administer nitrous oxide oxygen until the stage of analgesia is reached. Apprehension and nervous irritability on the part of the patient may contribute to shock, and the post-operative condition of the patient will be so much the less favorable, however successful the operation may be from a technical standpoint. For the same reason, before the operation each patient receives a dose of morphin, gr. 1/6 to  $\frac{1}{4}$ , and atropin, gr. 1/150. The value of the trained anæsthetist is never more strikingly illustrated than in these cases. It is true that the injection of the local anæsthetic, whether it be administered sacrally or regionally, is in the hands of the surgeon; but the anæsthetist, sitting at the patient's head, bathes his head and wets his lips, and is ready to administer nitrous oxide oxygen if the nervous condition of the patient demands it. No local anæsthesia is successful if the patient complains of pain and discomfort, even though he is persuaded or coerced into tolerating the operation. A nervous, apprehensive woman will frequently request inhalation anæsthesia, and if the request is urgent it should never be denied.

Frequently after the first administration of nitrous oxid-oxygen the degree of anæsthesia may be lessened, and the patient may finally come out from the stage of analgesia and yet, on account of the complete regional or sacral block, be practically unconscious of what is going on.

Another advantage in the use of sacral anæsthesia lies in the fact that the patient is entirely conscious after the operation and suffers no ill effects such as nausea, etc. The man from whom a prostate has been removed under sacral anæsthesia is often greatly stimulated and encouraged by being permitted to eat a light breakfast or to drink coffee or tea as soon as he has returned to the ward. He may have been conscious throughout the operation and though he has felt no pain, may have been apprehensive because of the fact that an extensive and dangerous operation was being performed, but the immediate assurance that he may eat lightly or take a drink at once often has an astonishing effect upon his morale, and he feels that after all the operation could not have been as serious as he feared.

Not only in the operating room but in the examining room of the genito-urinary surgeon, anæsthetic methods must be considered. For internal urethrotomy novocain is used, never cocain, for the danger of poisoning is too great, even with weak solutions. I have seen severe collapse follow the use of cocain. For cystoscopy, ordinarily an injection of 10 c.c. of a two to four per cent. novocain solution into the urethra suffices, but if the patient is very sensitive and no pyelogram is to be made, a hypodermic injection of morphin and atropin is given in addition. If a pyelogram is to be taken, however, it is usually unwise to give morphin, as the patient should retain sufficient sensibility to pain to be able to tell the operator when distention of the renal pelvis by the injected solution begins to produce pressure. The possibility that morphin may produce vomiting also contra-indicates its use when a pyelogram is to be taken.

In cases of tuberculosis of the bladder, when the bladder is small and contracted, sacral anæsthesia is the anæsthetic method of choice, for by its aid a cystoscopic examination can generally be made without causing any discomfort to the patient. For punch cases, sacral anæsthesia is contra-indicated and local infiltration of the bladder neck, together with nitrous oxide oxygen analgesia is used. This is essential because of the complete relaxation of the internal sphincter which is sometimes produced by the sacral block.

I believe that in no group of cases has the use of the sacral block and regional anæsthesia proved to be of greater value than in old men with enlarged prostates. This type of case in the past presented some of the greatest hazards in surgery. Renal insufficiency, with the danger that any further suppression of the action of the kidneys may produce acute uræmia and death, makes the use of general inhalation anæsthesia a serious menace. The lowered blood-pressure which is often produced by spinal anæsthesia is likewise disconcerting. In such cases as these, however, sacral anæsthesia

has made it possible to extend the possibility of operation until practically no patient need be refused the chance of added comfortable years which can be given by the removal of the prostate.

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# THE ANÆSTHETIC PREFERENCES OF AMERICAN SURGEONS

COMPILED FROM REPORTS RECEIVED FROM SIX HUNDRED  
AND FORTY SURGEONS

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SOME time ago the writer undertook to review some of the recent literature on anæsthesia. This study very soon led to a bewildering mass of arguments, each for the most part extolling the virtues of some particular anæsthetic or some method of giving an anæsthetic. Also, a not too critical analysis of the arguments presented might have seemed to have indicated the possibility that such an old stand-by as ether had already been, or very soon would be, very largely displaced by some of the newer anæsthetics.

In order to clear my mind on the subject I decided to obtain as near as possible a composite picture of the judgments of a representative group of American surgeons as shown by their choice of anæsthetics for several typical types of operations. To obtain the necessary data the following questionnaire was sent to approximately 1000 Fellows of the American College of Surgeons:

"I am desirous of ascertaining the present preferences of a considerable number of representative American surgeons as regards means of producing surgical anæsthesia. I will, therefore, greatly appreciate the favor if you will answer the following questions and return the same in the enclosed addressed envelope:

"1. What anæsthetic do you use as a rule in laparotomies in the average run of good risk cases?

"2. What anæsthetic do you use as a rule in laparotomies in cases comprising the poor risk group?

"3. What anæsthetic or anæsthetics do you generally use in inguinal hernia operations?

"4. What anæsthetic or anæsthetics do you ordinarily use in goitre operations?

"5. What anæsthetic do you ordinarily use when called upon to use anæsthesia in fracture cases?

"6. Do you use spinal anæsthesia? If so, in what class of cases do you use it?

"Any comments regarding your views as to the use of anæsthetics will be much appreciated. A summary of the answers received will be sent to all surgeons answering this questionnaire."

The selection of names was made at random, six or seven names to the page from those registered as surgeons or gynecologists in the 1926 year book of the College.

Six hundred and forty replies were received. The answers to questions Nos. 1 to 5 are summarized in Table I. The numbers in the several columns of the table do not exactly correspond with the number of replies received. This is because a few surgeons in answering one or more questions report equal preference for two anæsthetics. If so, both anæsthetics are given

equal credit. In the case of fractures and goitres a few surgeons report that they do not treat these cases at all. The additions and subtractions due to the reasons just enumerated are so few in number as to have no noteworthy effect on the figures presented.

From the answers to the first question, it is evident that for operations of the type of the average run of laparotomies 555 out of 657 use ether, alone or rely largely on ether after a primary anæsthesia started with some other of the volatile anæsthetics. One-half of all the surgeons and approximately 60 per cent. of the ether-using surgeons use straight ether. Of the

TABLE I  
*Summary of Answers*

Question No.	I.	II.	III.	IV.	V.
Ether .....	329	113	195	113	249
Nitrous oxide-ether sequence .....	198	106	85	45	109
Nitrous oxide-oxygen .....	28	87	27	55	109
Nitrous oxide-ethylene .....	8	8	0	5	6
Ethylene .....	33	51	32	35	35
Ethylene plus ether or ethylene-ether sequence .....	25	8	4	3	9
Ethyl chloride .....	0	0	0	0	1
Ethyl chloride-ether sequence .....	3	0	2	1	9
Ethyl chloride-ethylene sequence .....	0	1	0	0	0
Chloroform .....	1	0	1	0	3
Local—including regional and paravertebral .....	5	113	255	147	4
Local—ether .....	4	30	20	26	0
Local—gas oxygen .....	13	110	27	118	0
Local—gas oxygen-ether .....	4	1	0	1	0
Local—ethylene .....	5	28	5	15	2
Spinal .....	2	17	7	0	0
Colonic ether and oil .....	0	0	0	6	0

reporting surgeons who start with some other anæsthetic and switch to ether, the great majority use the nitrous oxide-ether sequence, a few use ethylene plus ether and three surgeons use the ethyl-chloride-ether sequence.

Thirty-three, or 5 per cent., of the reporting surgeons use ethylene, 4 per cent. use nitrous oxide and oxygen and just over 1 per cent., ethylene and nitrous oxide.

Three surgeons report that they do their ordinary laparotomies under local anæsthesia, two use paravertebral, one uses ether or spinal and 25, or 4 per cent., use local plus one or the other of the volatile anæsthetics. Only one surgeon out of the 640 mentions the use of chloroform for laparotomies.

The outstanding fact in the answers to Question 1 is that approximately 85 per cent. of 640 surgeons scattered all over the United States use ether as their standard anæsthetic in operations of the type of the average laparotomy. As the human animal is constituted, this is about as near a unanimous verdict as is ever obtained from scattered individuals:

The answers to Question 2 show a wide diversity of opinions and prac-

tices. Because some of the surgeons use more than one method, 672 methods are recorded for 640 answering surgeons. Two hundred and sixteen of the 329, or practically two-thirds of the straight ether users, abandon ether and shift to some other form of anæsthesia. Likewise, 112 of the 226 ether-sequence users abandon ether.

Of the total shifts, 18 (5 per cent.) go to ethylene, 59 (17 per cent.) go to gas-oxygen, 110 (33 per cent.) go to straight local and 143 (42 per cent.) go to local and some volatile anæsthetic, chiefly gas-oxygen, and 16 (5 per cent.) shift to spinal anæsthesia.

Altogether approximately one-half of the reporting surgeons state that they use a different method of anæsthesia when operating on poor risk laparotomy cases from that used for ordinary major operations. This shift is practically entirely away from ether. Although an analysis of the individual answers and comments shows a great deal of uncertainty on the part of individual surgeons as to what choice of anæsthetic they should make, it is interesting and possibly highly significant that 72 per cent. or approximately three-quarters of the shifts are to local anæsthesia, or local reinforced if necessary with one of the volatile anæsthetics.

Question 3 was inserted because it covers a rather typical example of a common operation performed by all surgeons and one requiring no very special relaxation but nevertheless each operation covering an appreciable period of time. Again, we find almost half (44 per cent.) of the reporting surgeons using a different form of anæsthesia from the one they use in the average run of laparotomies. In this case, however, the shift is not from ether alone but from all forms of volatile anæsthetics and once the surgeons have decided to make a shift, there seems to be but little question as to their choice. Two hundred and fifty, or 88 per cent., go to straight local, 26, or an additional 9 per cent., of those shifting go to local reinforced if necessary with one of the volatile anæsthetics. Seven use spinal anæsthesia.

Although local anæsthesia is very popular in hernia operations, the surgeons using some form of local anæsthesia for hernia operations comprise less than half (47 per cent.) of the total. Forty-three per cent. use some form of ether anæsthesia.

The answers to Question 4 show that in goitre operations more than half of the ether users shift to some anæsthetic other than ether. This shift is chiefly to local anæsthesia and local plus nitrous oxide and oxygen, although a few have changed to nitrous oxide and oxygen, and we also find two more surgeons using ethylene than use ethylene for the average run of laparotomies. In goitre operations we also find a form of anæsthesia not mentioned in the answers to the previous questions, namely, colonic ether and oil anæsthesia used by six surgeons.

The answers to Question 5 show a moderate shift from ether, although 376 (70 per cent.) of the 536 surgeons answering this questionnaire use some form of ether anæsthesia when an anæsthetic is necessary for the reduction of fractures. One hundred and nine (18 per cent.) surgeons use nitrous

oxide and oxygen. In this group we find two anæsthetics scarcely mentioned previously. Sixteen surgeons state that they use "light chloroform" anæsthesia and one surgeon uses ethyl chloride.

The practically complete abandonment of chloroform as an anæsthetic used in major anæsthesia is probably the most important change in the use of the volatile anæsthetics which has taken place during the past twenty-five years. However, judging from comments relative to chloroform, it is quite evident that a number of the surgeons answering the questionnaire feel that owing to one or more court decisions and some adverse criticisms, chloroform has at present a far worse reputation than it deserves.

Question 6 concerning the use of spinal anæsthesia was answered by 622 surgeons. Of those answering 419 (67 per cent.) state definitely that they do not use spinal anæsthesia. A considerable number of those not now using spinal anæsthesia state that they did formerly but have abandoned its use for one reason or another. One surgeon states that after an experience of 1056 cases he abandoned spinal anæsthesia because of the headaches which he was unable to avoid. Several state that they now use caudal and sacral anæsthesia in the cases in which they formerly used spinal anæsthesia. Approximately 90 per cent. of those who use spinal anæsthesia state definitely that they use it only occasionally in special types of bad risk cases. Most surgeons specified definitely the conditions under which they employed this form of anæsthesia. Eighty surgeons mentioned prostates; 41, amputations of lower extremities; 22, pelvic and vaginal work; 16, "poor risks"; 21, hemorrhoids and rectal work; 13, diabetes; 12, operations below the diaphragm; 10, severe injuries of lower extremities; 9, senile gangrene and old people; 4, bladder and genito-urinary; 4, cardiac cases; 3, fractures; and one surgeon mentioned intestinal obstruction.

The problems associated with anæsthesia have been constantly before each individual surgeon from before his first operation up to the present time. A surgeon's views on anæsthesia are usually the product of a long series of objective experiences and the deductions drawn therefrom. It is, therefore, not surprising that nearly half of the answering surgeons took the opportunity to comment in a definite and forceful manner regarding their views as to the use of anæsthetics. While from their very nature these highly individualistic expressions of opinion often reflecting the personalities of the writers cannot be summarized in statistical terms, it is possible to classify the general trend of these comments under several different headings.

*Ether.*—A very considerable number of the ether users state that they have from time to time tried one or more or all of the other volatile anæsthetics but for one reason or another have been forced to the conclusion that all factors considered, ether is the one safest anæsthetic. Many of these surgeons emphasize their point by stating their belief that if the same amount of skill and care is given to an ether anæsthesia as is mandatory in other forms of anæsthesia most of the objections to ether are largely elimi-

nated. Others emphasize the advantages of the complete relaxation attainable under ether.

*Nitrous Oxide.*—All seem to be agreed that the safety and usefulness of gas-oxygen as a major anæsthetic is dependent upon the skill and experience of the anæsthetist. The most numerous and most enthusiastic commenters on nitrous oxide are those who use gas oxygen in conjunction with local anæsthesia in both laparotomies and goitres. A number of former gas-oxygen users state that they are now using ethylene.

*Ethylene.*—Many of the ethylene users are extremely enthusiastic over its use. Several report three years' continuous use with no accidents or untoward results of any kind. On the other hand, some state that to get satisfactory relaxation they have to add ether or local infiltration in a considerable portion of cases. Several mention excessive bleeding from the smaller vessels under ethylene. Several mention the cost, saying that they can afford to use it only with their more well-to-do patients. Several have given up the use of ethylene because of the dangers of explosion which they think outweigh its advantages. Ethylene is at present used more or less extensively by approximately 10 per cent. of the surgeons answering the questionnaire.

*Sacral and Caudal Anæsthesia.*—Although sacral or caudal anæsthesia was not mentioned in the questionnaire, 69 (11 per cent.) of those answering the questionnaire took the occasion to make favorable mention of this special form of regional anæsthesia. The comments were uniformly favorable and often decidedly enthusiastic. From the answers as returned, it would seem that over 10 per cent. of surgeons are at present using this form of anæsthesia for rectal, lower pelvic and bladder operations.

# OBSERVATIONS ON THE EFFECT OF GLYCOSURIA IN SURGERY\*

By HERBERT A. BRUCE, F.R.C.S. (ENG.)

FREDERICK HIPWELL, M.D.

AND

J. WINFIELD RUSH, M.D.

OF TORONTO, CANADA

A VERY different situation confronts the surgeon of to-day in respect to an operation upon a diabetic to that which existed but four short years ago. Faced with a mortality rate of 30 per cent., with frequent acidosis and infection and uncertain results, it cannot be wondered at if he approached such an operation with considerable misgiving. But all this has been changed since the discovery of insulin and the acquisition of more detailed and comprehensive knowledge of diet and the treatment of diabetes mellitus. Surgeons now undertake an operation upon a diabetic with as much confidence in the result as though he were not suffering from a natural insulin deficiency. Our cases are ninety-seven in number with two deaths, a mortality rate of 2.1 per cent. One patient had advanced carcinoma of the stomach and died two weeks after a gastro-enterostomy; the second was suffering from advanced diabetic gangrene and succumbed suddenly from a cardiac condition on the tenth day after operation.

While the number of operations performed upon diabetic patients has increased enormously, there has been comparatively little reference to the subject in the literature. Considering the broad phases of the subject, certain physiological features or theories should be kept in mind, particularly that diabetes mellitus is a profound disturbance of metabolism affecting primarily the carbohydrate mechanism.

The chemistry of the body is altered in such a manner, however, that carbohydrate metabolism is not affected alone. Protein and fat enter into the change very materially. For instance, we have observed that excessive fat decreases the glucose tolerance and tends to incite ketonic acidosis.

The effect of an anæsthetic upon a diabetic should be noted. We have observed a rapid rise from 100 to 300 mgs. of blood sugar during the administration of ether of average duration. This has occurred on more than one occasion in spite of insulin having been administered previous to operation. Further, it is known that on the administration of an anæsthetic the supply of stored glycogen is rapidly exhausted, probably causing the increase in blood sugar. These occurrences are more marked after ether anæsthesia than after gas oxygen. Infiltration anæsthesia introduces the possibility of devitalization of tissue in which the metabolism is already deranged, and may give

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\* Read before the American Surgical Association, May 14, 1927.

rise to sloughing. Regional anæsthesia in selected cases with or without supplementary gas oxygen is ideal and has given rise to no marked increase in blood sugar.

Several patients were fed diets high in carbohydrates with large amounts of insulin previous to operation. This was done that an excessive amount of glycogen might be stored. Clinically, however, these cases did not do better than those not so prepared. The probable explanation of this phenomenon is to be attributed to the effect of the anæsthetic upon stored glycogen.

In operating upon diabetics our procedure generally is as follows:

Where possible, a patient is kept under observation and treatment for sufficient time to render the urine clear of sugar and acetone, with a fasting blood sugar approximating normal. Diet is constructed so as to yield for the ordinary adult from 25 to 30 calories per kilo of body weight. Insulin is used where necessary and in sufficient amounts to accomplish this result.

On the day of operation, from two to three hours before administering the anæsthetic, the patient is given the usual dose of insulin for that time of the day. The glucose value of the meal is given in the form of orange juice and glucose. Following the operation a blood sugar is estimated, and if above 200 mgms. per 100 c.c., insulin is administered—the dose varying with the need demonstrated prior to operation. Close watch is kept on the blood sugar and the urine for the balance of the twenty-four hours. An attempt is made to keep the urine clear of sugar and acetone and the blood sugar no higher than 200 mgms. per 100 c.c. If the operation has been prolonged an interstitial is given of  $2\frac{1}{2}$  to 5 per cent. of glucose in normal saline. This is repeated as necessary. We do not encourage our patients to take quantities of fluid by mouth for the first twelve hours. Within twenty-four hours we try to have the patient ingesting food which consists for the most part of carbohydrate and protein in the same proportion as that contained in the diet previous to operation. Fats are intentionally allowed to fall as low as possible. Should there be any nausea or abdominal distress, we continue with interstitials of glucose and saline.

It is well known that infection or absorption from an infective focus disturbs materially the balance between insulin deficiency, insulin dosage and diet. The removal of a focus of infection would lead us to expect a decrease in the necessary insulin dosage. (*Vide* Cases I and IV.)

We have observed that healing of a wound will take place by first intention in the presence of a blood sugar somewhat above normal with the patient showing small amounts of sugar in the urine when no acetone is present. (*Vide* Cases II and IV.) It seems to us that the incomplete combustion or metabolism of fat plays more of a rôle in this connection than does increased blood sugar as pointed out by Woodyatt and others.

Types of diabetic patients met with by the surgeon readily group themselves into the following classes:

1st.—Those cases which require immediate surgical intervention, such as acute appendicitis, intestinal obstruction, hemorrhage, etc.

2nd.—Cases in which there is no urgency, but where surgery is considered the logical treatment, such as various gynæcological and plastic conditions.

3rd.—The complications of diabetes, such as carbuncle or diabetic gangrene.

4th.—That group of cases in which surgery is undertaken in the hope of improving the actual diabetic condition.

Emergency surgery allows no preparation whatever, but it is seldom that an operation cannot be delayed to make a blood sugar estimation. If the patient is known to be diabetic with definite increase in blood sugar content, insulin is administered previous to the operation, the amount given depending on the severity of the symptoms of diabetes. The after-treatment follows the same plan generally to that previously detailed, the difference being, however, that more insulin is used and we administer it every four hours with a blood sugar control. Within five to seven days there has been, in most instances, a return to the pre-operative diet and insulin dosage.

The following cases illustrate the classification we have made:

CASE I.—M. S., age forty-three, female. Had been ailing for ten days with acute appendicitis when admitted to the hospital. A large tender mass could be made out in the right iliac region extending into the pelvis—clearly an appendiceal abscess. The skin was dry and the breath loaded with acetone. Urine contained 1.9 per cent. sugar and the blood sugar was 384 mgms. per hundred c.c. fasting. She also had a large soft bilateral enlargement of the thyroid with exophthalmos. Pulse 160.

Patient was given 15 units of insulin and operated upon the day following admission to the hospital. At operation we found a ruptured appendix and a mass of infiltrated tissue and pus surrounding this. It had infiltrated the wall of the cæcum, involved the right ovary and the right side of the uterus. Appendix and right ovary were removed and the cavity drained.

Patient did very well following operation. There was a good deal of purulent discharge from the wound. The diet consisted of carbohydrate 100 grams, protein 60 grams, and fat 100 grams. This amount of carbohydrate was thought advisable to combat the acidosis which was very severe. Insulin was increased 70 units per day and blood sugar estimations made twice daily. As the discharge cleared up insulin was reduced 10 units per day, because we were obtaining moderate hypoglycæmic reactions. The same diet was continued. The daily dose of insulin was determined by the amount of sugar in the previous twenty-four hours' urine. After two weeks the discharge had become non-purulent; the insulin was reduced to 10 units a day. The blood sugar was 156 mgms. There was no glycosuria. The following day insulin was discontinued, but there appeared a trace of sugar in the urine. This showed the carbohydrate tolerance to be less than 100 and as we had still to combat some acidosis, it was necessary to prescribe, indefinitely, 10 units of insulin per day.

CASE II.—M. H., age forty-six, female. Patient has been diabetic for four years but was controlled with a diet consisting of 90 grams carbohydrate, 80 grams of protein, 120 grams of fat and from 40 to 45 units of insulin in two doses daily.

Persistent backache and metrorrhagia existed for several years due to uterine myomata.



## THE EFFECT OF GLYCOSURIA IN SURGERY

Hysterectomy with removal of cystic right ovary was performed under ether anesthesia.

Blood sugar fasting before operation was 117 mgms. per 100 c.c.

Blood sugar immediately after operation was 100 mgms. per 100 c.c.

Blood sugar ten hours after operation was 206 mgms. per 100 c.c.

She received twenty-five units of insulin two hours before operation and at the same time 200 c.c. orange juice with twenty grams glucose. Recovery was uneventful, with primary healing of the wound. While frequently sugar was found, ketone bodies occurred only in very small amount in the urine.

At the time of writing ten weeks after operation, she is in excellent condition, has a normal blood sugar, a satisfactory diet and her tolerance for food is not diminished—her diet and insulin previous to operation proving quite adequate.

CASE III.—C. G., age sixty-six, male. Was admitted to the hospital practically in coma with gangrene of the fifth toe of the left foot, due to the paring of a corn. Temperature 100, pulse 110, skin dry, breath strongly acetone. The urine contained 2 per cent. of sugar, 47 grams being excreted in twenty-four hours. On unrestricted diet ketone bodies were found in the urine in abundance. Blood sugar fasting was 200 mgms. per 100 c.c. Patient had never had treatment for diabetes.

He was kept under observation for a week, given forty units of insulin per day with a diet consisting of 90 grams carbohydrate, 70 grams protein, 110 grams fat, at the end of which time an amputation of left leg at the point of election was performed under gas and oxygen anesthesia. The blood sugar did not rise perceptibly following this and the sugar in the urine was slight. He made a good recovery and the wound healed per primum.

CASE IV.—J. B., age forty-six, male. Patient was receiving a diet of carbohydrate 90 grams, protein 85 grams, fat 150 grams and required twenty-five units of insulin daily, in two doses. Insulin was decreased until he used only 17 units daily.

After ten months excellent health with diet and insulin during which he gained two pounds, he contracted a severe influenza. His insulin need increased and his tolerance for fat became much depreciated. He complained of pain, dull in character in the right upper quadrant of the abdomen, and a rounded mass was felt which was diagnosed as an enlarged gall-bladder. An X-ray of the gall-bladder after intravenous iodekon gave no shadow.

The gall-bladder was removed under paravertebral and gas oxygen anesthesia. Cultures of the content were negative, but the wall of the gall-bladder was infiltrated with leucocytes.

Recovery was uneventful except for the large amount of insulin used—as much as 250 units per day being administered for several days.

Immediately prior to operation he required 160 units daily with a diet of carbohydrate 90 grams, protein 50 grams, fat 100 grams. He was discharged from hospital, using 160 units daily with the same diet as when admitted.

Three months after operation his insulin need was 120 units daily and his diet has been increased to carbohydrate 90 grams, protein 65 grams, and fat 130 grams.

That the story of diabetes is complete is doubted by all. The recent news concerning a new discovery on this Continent with a report from Europe that further discoveries have been made—lead us to believe that in the near future there will be more startling and helpful solutions to this problem. We are by no means satisfied that diabetes mellitus is a disease of the pancreas. There is increasing evidence that other organs and tissues play a

very important part. Also, we are led to believe from reports of able investigators that certain vegetable products, enzymes or other substances may play a very active part in carbohydrate metabolism. We shall look to the future with great expectancy and trust that within our allotted span we may hear the full story told.

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# RESULTS OF THE SURGICAL TREATMENT OF CARCINOMA OF THE STOMACH\*

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FROM THE SURGICAL CLINIC OF THE PRESBYTERIAN HOSPITAL OF NEW YORK

ONE is impressed with the frequency with which brilliant results in isolated cases of carcinoma of the stomach are reported by individual surgeons. One is even more impressed by the infrequency of reports from surgical clinics, showing complete follow-up results in all their cases of carcinoma of the stomach.

A study of all cases surgically treated in any one clinic, if it be based on personal observation in a follow-up organization, will obviously offer accurate data on the results of our methods as exemplified by that individual clinic. A collection of such reports from many surgical units would be of great value.

If effort is to be constructive, in the presence of our limited knowledge of the subject as a whole, it must come from a full realization of the facts, with regard to success and failure of treatment, and what factors enter into each.

Stout, in an analysis of 565 cases of carcinoma of the alimentary tube admitted to the Presbyterian Hospital of New York during a ten-year period, reports 230 carcinomata of the stomach, or 40 per cent.

The purpose of this paper is to present some data on 147 of these cases, surgically treated between 1916 and 1926, with their follow-up results.

There are real difficulties in presenting clearly the results of such a study in a given recent group of cases. The difference in the total number of cases followed for various periods of time is a question with which it is difficult to deal, and one encounters further complications in discussing the cases still being followed for varying lengths of time, referred to as "current cases," some of which have been followed for but a short while. For these reasons, statistics may be confusing and even misleading.

Obviously, an analysis of a group of cases, operated upon thirty years ago, for example, would be more complete and simpler of presentation because of the fact that it would establish a possible long follow-up period for each case, and furthermore, in all probability there would be no current cases, the follow-up records on all having been completed. Unfortunately, the date for this type of study is not available.

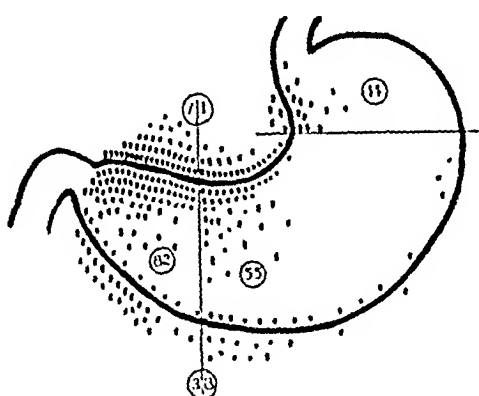


CHART I.—Carcinoma of Stomach.—Site of lesion and metastases as recorded by operator.—Metastases.—Regional lymph-nodes of greater or lesser omenta, 109; Liver, 22; Pancreas, 13; Retroperitoneal nodes, 13; Peritoneum, 3; Small intestine, 2; Colon, 1; Umbilicus, 1; Site not specified, 7; "Practically the entire organ", 3; "Stomach normal", 1. (Autopsy showed high cardiac site.)

\* Read before the New York Surgical Society, November 24, 1926.

The following chart does not refer to the particular cases analyzed in this article.

CHART 2

*Report of Pathological Findings in Fifty-seven Autopsies of Carcinoma of the Stomach*  
By Dr. W. C. Von Glahn

*Pathological Department, Presbyterian Hospital*

Number of cases, 57.

Site:	Cases	Per cent.
Region of pylorus .....	26	45.6
Lesser curvature .....	16	29.8
Greater curvature .....	9	17.5
Walls .....	14	24.0
Type:		
Adenocarcinoma .....	37	64.9
Scirrhus carcinoma .....	13	22.8
Colloid carcinoma .....	7	12.3
Metastases:		
Regional lymph-nodes .....	23	39.6
Retroperitoneal lymph-nodes .....	19	32.7
Mesenteric lymph-nodes .....	9	15.5
Mediastinal lymph-nodes .....	8	13.8
Bronchial lymph-nodes .....	1	1.7
Liver .....	23	39.6
Peritoneum .....	11	18.9
Lung .....	10	17.2
Pancreas .....	9	15.5
Omentum .....	9	15.5
Pleura .....	7	12.0
Intestine .....	3	5.2
Colon .....	2	3.5
Diaphragm .....	3	5.2
Adrenal .....	4	7.0
Heart .....	1	1.7
Mesentery .....	4	7.0
Ovary .....	4	7.0
Breast .....	1	1.7
Uterus .....	1	1.7
Kidney .....	4	7.0
Ureters .....	1	1.7
Tubes .....	1	1.7
Umbilicus .....	1	1.7
Bones .....	2	3.5
Spleen .....	1	1.7
Thyroid .....	1	1.7

THE FOLLOWING STATISTICS REFER TO CASES ANALYZED BY THE AUTHOR

No. of cases: 147 (males, 97; females, 50; or approximately 50 per cent).

Age: Youngest, 33 years (9 cases under thirty-five years).

20-30 years .....	0
30-40 years .....	20
40-50 years .....	35
50-60 years .....	57
60-70 years .....	30
70-80 years .....	5

## SURGICAL RESULTS IN STOMACH CANCER

*Nationality.*—Nineteen nationalities are represented in this group, a fact which has no significance other than that it is representative of the international character of the clinical material in a given New York Hospital at a given site.

*Occupation.*—This factor seemed to be irrelevant in this series.

*Outstanding Symptoms.*—Duration before admission of symptoms directly referable to the gastro-intestinal tract was as follows: Shortest duration, one week; longest duration, three years. The average length of time during which a

patient had noticed symptoms which, upon careful investigation, seemed to refer directly to gastro-intestinal tract, was eight months. Records of seven

cases discarded as incomplete in this detail.

*Loss of Weight.*—In only two cases in this series, where it was recorded, was there found to be no loss of weight up to the time of admission. In 125 cases, the average loss of weight was thirty pounds. In 22 cases, weight loss was inaccurately expressed, as for example, "considerable" or "marked," and therefore in those instances the records were useless. An accurate estimation of exact period of time in which weight loss had occurred

could not be made from available data, but in many cases it preceded onset of gastro-intestinal symptoms, and had at first been disregarded by patient.

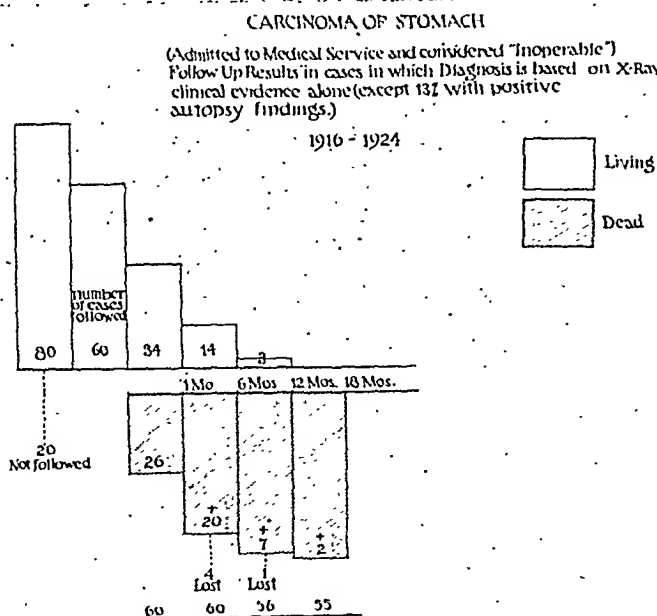


CHART 3.

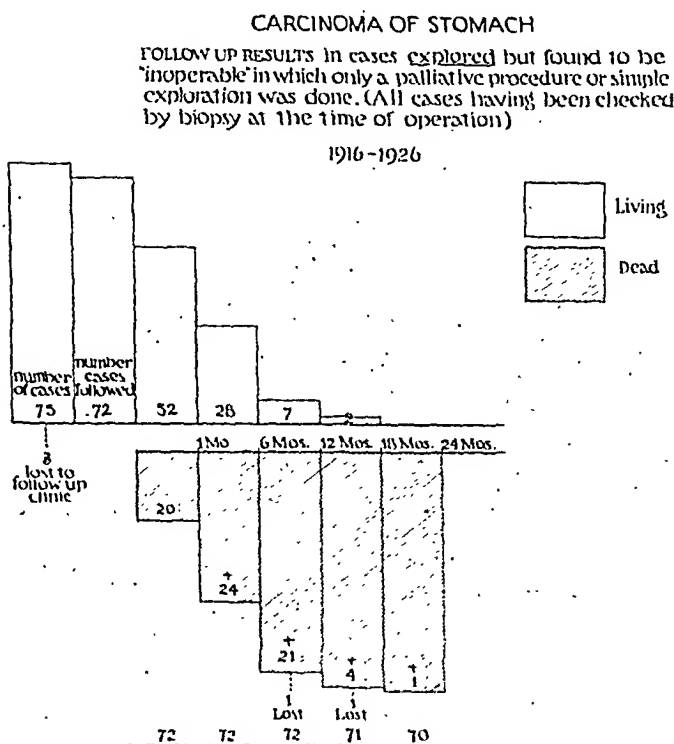


CHART 4.

Statistical chart showing course of cases of carcinoma of stomach operated upon (including exploratory and palliative procedures)

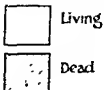
(Current cases refer to those that are still being followed. The number is included in the total of the living.)



### CHART 5.

Follow up results in cases in which resection was performed

(current cases refer to those that are still being followed. The number is included in the total of the living.)



15.6% of the cases in which radical resection was carried out for cancer are alive 5 years after operation.

### CHART 6.

## SURGICAL RESULTS IN STOMACH CANCER

*Pain.*—In 122 cases—or 86 per cent.—pain was a distinct symptom. In this analysis, discomfort, a feeling of fulness, etc., were not included under the heading of “pain.” In 20 cases, or 14 per cent., there was absence of pain before admission.

In five cases, accurate data was available.

*Vomiting.*—In 103—or 71 per cent.—of the cases, repeated vomiting was recorded. In 42—or 29 per cent.—the history recorded the absence of vomiting. In two cases this feature was not noted.

*Abdominal Mass.*—In 78 cases—more than half—an abdominal mass had been recorded by the staff before operation. In 62 cases—or 44 per cent.—the absence of an abdominal mass had been recorded. In seven cases, no note had been made concerning a mass.

The features of the above statistics, which especially warrant reflection, would seem to be as follows:

Nine of the cases which, upon exploration, were found to present extensive carcinoma of the stomach, were patients under thirty-five years of age.

The average duration of symptoms directly referable to the gastrointestinal tract was—in this group—eight months. It is obvious that in many of these cases careful investigation

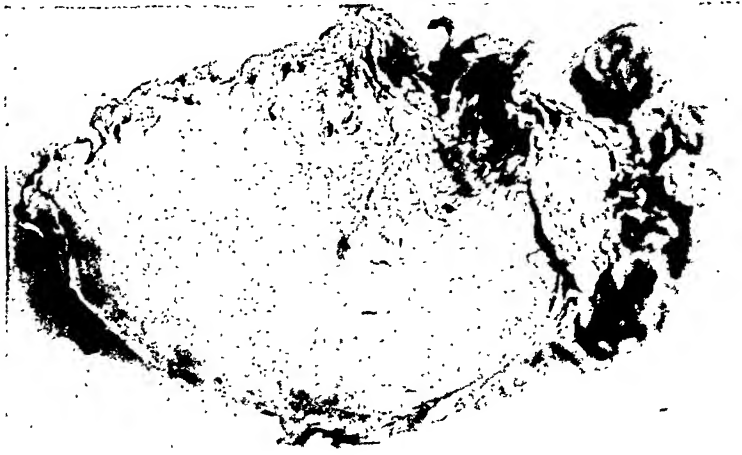


FIG. 1.—Case I.

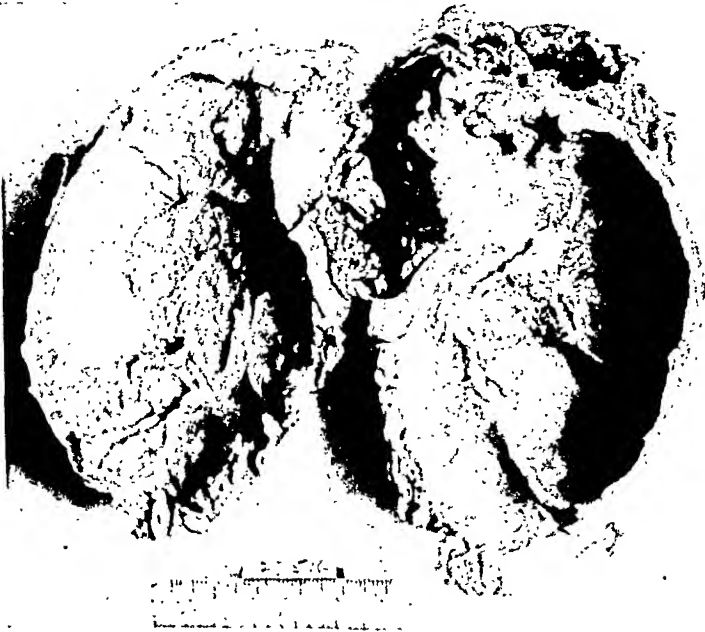


FIG. 2.—Case I.

by the patient's physician would have made possible a more hopeful outcome by earlier operation.

The subtle factor of unexplained loss of weight or strength in the cancer-bearing age is one which must constantly be borne in mind by every prac-

tioner, for it is not infrequently the only early danger signal in cancer of the stomach, as in cancer elsewhere.

The writer was impressed by the high percentage of cases in which actual pain was a real feature, viz.: 86 per cent. This is without question especially high in this series. On the other hand, when one considers the fact that 71

per cent. of the cases complained of repeated vomiting, it gives one an idea of the relatively advanced type of lesion in this particular group. This fact is further emphasized by the evidence of an abdominal mass, which was present in more than half of the total number of cases, as noted before operation.

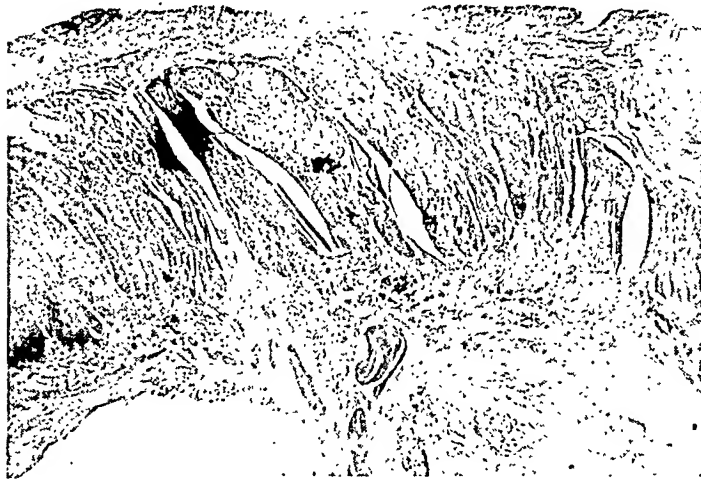


FIG. 3.—Case I.

the anatomical site, as recorded by the operator, with lymph-node or other metastatic sites noted.

Following this is a more accurate statistical chart, made by Dr. Von Glahn, as a result of complete autopsy study, in which the limitations for complete exploration, encountered by the surgeon, are eliminated. (See Chart 2.)

The follow-up results are recorded by the foregoing charts, in which is shown the outcome in every case of carcinoma of the stomach (with the exception of three cases lost to follow-up) operated upon in the Presbyterian Hospital during the given period, whether or not reaction was possible.

Every case is included, despite the fact that in a certain group there was no possibility of radical removal of the growth.

The course of untreated—but proven—carcinoma of the stomach, as when a simple exploration with biopsy is done, must engage our attention as well as the case in which radical resection is possible. The results of resection must

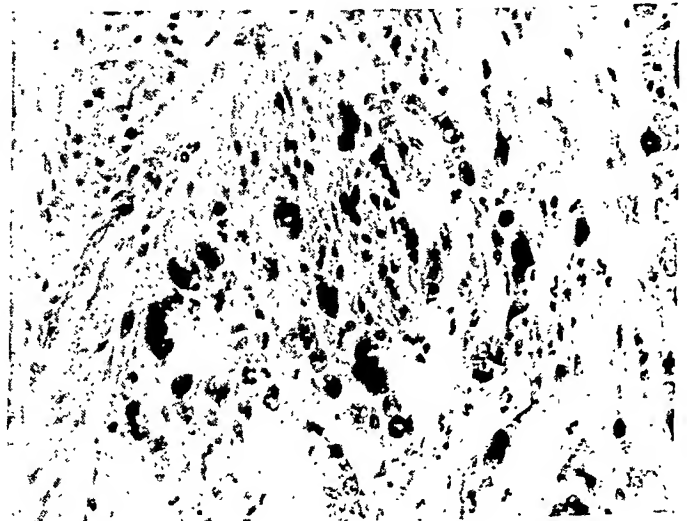


FIG. 4.—Case I.



## SURGICAL RESULTS IN STOMACH CANCER

be compared not only with normal individuals, but with results carefully noted in untreated cases, in order to arrive at a true evaluation of therapy in this disease. This seems particularly important in view of the statistics, recently published, emphasizing the duration of life in cases of untreated cancer in various anatomical sites.

### CONCLUSIONS

One cannot, of course, draw definite conclusions from the study of such a small series. On the other hand, one gains definite impressions from even a small number of cases, if carefully followed.

1. In the above study, the cases were well-advanced upon admission to the hospital, due to the failure on the part of the examining physician, in the great majority of cases, to recognize the possibility of cancer. This fact stands out, not only because of the advanced pathology found, but because of the average duration of symptoms, which was eight months. In only 32 cases out of a total of 147, did the operator feel that an attempt to resect was justified.

2. X-ray examination of the stomach should be carried out wherever even a suspicion of carcinoma of the stomach arises, and in fact even when only unexplained loss of weight exists. X-ray facilities should be afforded the poor patient at a nominal cost.

3. Exploration is not contra-indicated by an abdominal mass, and resection should be attempted, when metastases are not present, in cases presenting large local lesions, whenever such radical procedure is technically possible.

4. Enlarged nodes in the regional lymph-glands are not infrequently hyperplastic.

5. The removal of a very extensive local growth may be followed by a

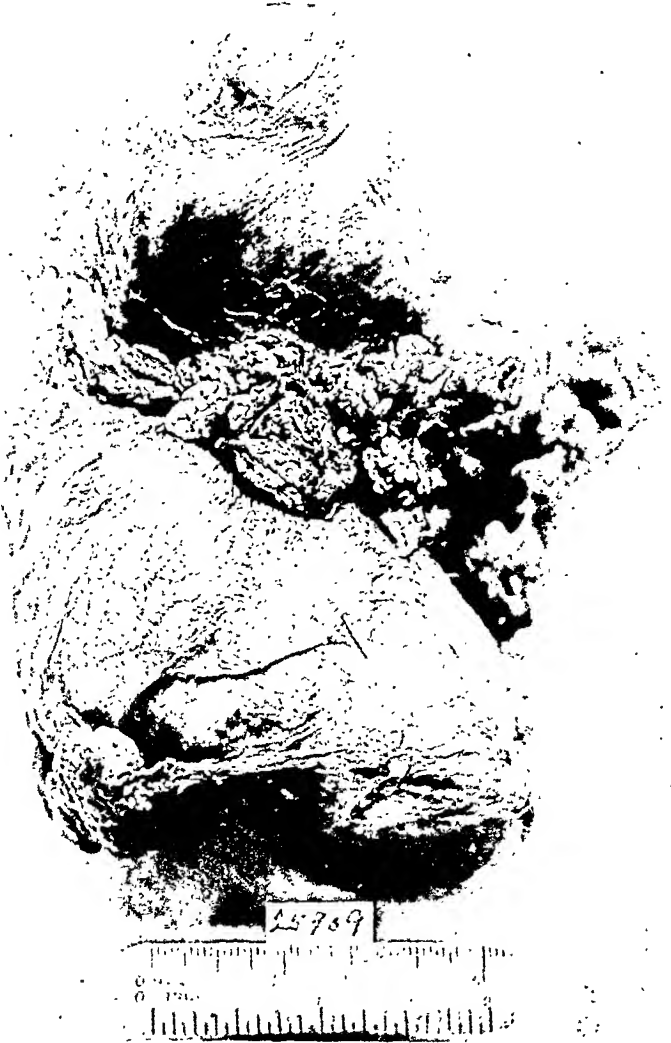


FIG. 5.—Case III.

brilliant result. Relative prognosis is difficult, despite gross and microscopic study of the specimen.

6. Many patients are relieved of distressing symptoms by a palliative procedure when a radical operation is impossible.

7. In this series, the mortality following radical operation is higher than the condition of the patients or the technical difficulties justify. Concentration of the work, in the general hospital, to a small group of men particularly interested and especially

trained by experience in this branch of surgery, will reduce the operative mortality. The fact that, of 32 cases in this series of cases of carcinoma of the stomach, where resection was carried out, five patients are alive and well after a period of five years, is gratifying.

8. A 15 per cent. satisfactory result for the five-year period in this group of relatively advanced carcinoma of the stomach, should be a source of renewed vigor in attacking the problem. Concentration should be directed to early diagnosis, lowering operative mortality by increased effort in ante-operative, operative, and post-operative skill in handling these cases, and finally by constant, undivided



FIG. 6.—Case III.

attention, in maintaining a Follow-up Clinic which has for its aim 100 per cent. data, consistently recorded by personal interview and examination. Maintenance of this concentrated effort is already under way in this clinic.

#### CASES

(No. I.) J. S. (A patient of Doctor Parsons'.) Female, fifty-five years of age. No. 54,148. Fifty-four months after operation.

The patient came to the hospital on May 22, 1922, complaining of "indigestion," distress in upper abdomen, sour eructations, and loss of weight (thirty pounds in one year). At examination, no mass could be made out in the abdomen.

## SURGICAL RESULTS IN STOMACH CANCER

X-ray showed a filling defect of the antrum, on the lesser curvature side, involving the pylorus. There was considerable residue.

At operation, Doctor Parsons found upon the lesser curvature in the prepyloric region, "an indurated mass 3 cm. in diameter, involving the stomach to within 1 cm. of the pylorus, obstructing this by its size. The centre of the mass presented a deep crater. There were a few enlarged lymph-nodes in the lesser omentum. Just below the greater curvature, another enlarged node was found, which was soft. The liver and pancreas appeared normal. A resection was performed with an anterior end-to-side anastomosis (Polya-Balfour) with entero-enterostomy."

The pathological report showed "adenocarcinoma of the stomach. Sections of all accompanying lymph-nodes give no evidence of metastases."

The post-operative course was uneventful.

X-ray follow-up at one year and at two years after operation revealed a normally functioning gastro-jejunostomy.

It is now fifty-four months (four and a half years) after operation, and the patient is without symptoms, economically capable, and physical examination reveals a firm, abdominal scar, with no evidence of further

trouble. The patient weighs thirty-three pounds more than when admitted to the hospital.

(No. II.) M. G. (A patient of Dr. Adrian Lambert's.) Female, thirty-four years of age. No. 50,098. Sixty-six months after operation.

The patient was admitted to the hospital, May 4, 1921, with a two months' history of "pain and a lump" in the abdomen, vomiting and considerable loss of weight.

Physical examination revealed "a firm, large mass to the left of the umbilicus." X-ray showed "a large filling defect on the greater curvature side of the stomach, near—but not involving—the pylorus."

Doctor Lambert operated upon the patient in May, 1921 (five and a half years ago), finding "on the greater curvature, about 5 cm. from the pylorus, a large mass, 6 cm. in diameter, projecting into the stomach. The lesion was more extensive posteriorly than anteriorly. The mass was firmly adherent to the transverse meso-colon directly along the path of the medio-colic artery; in fact, the colica media was incorporated so intimately in the mass that it could not be dissected out with any degree of success. The liver and pancreas were apparently not involved. A partial gastrectomy was done, leaving about 10 cm. of the stomach. The duodenal and gastric stumps were closed, and a posterior gastro-jejunostomy was performed by suture, after which the compromised portion of the transverse colon was resected, and an end-to-end colostomy carried out."

The pathological report was as follows: "Springing from the posterior wall of the stomach and involving the lesser curvature, is a large, nodular, fungating tumor, 8 cm. long and involving the entire circumference of the stomach, with the exception of about 4 cm. of the mucous membrane on the anterior surface. Along the greater curvature there are many enlarged lymph-nodes, varying from one to one and one-half cm. in

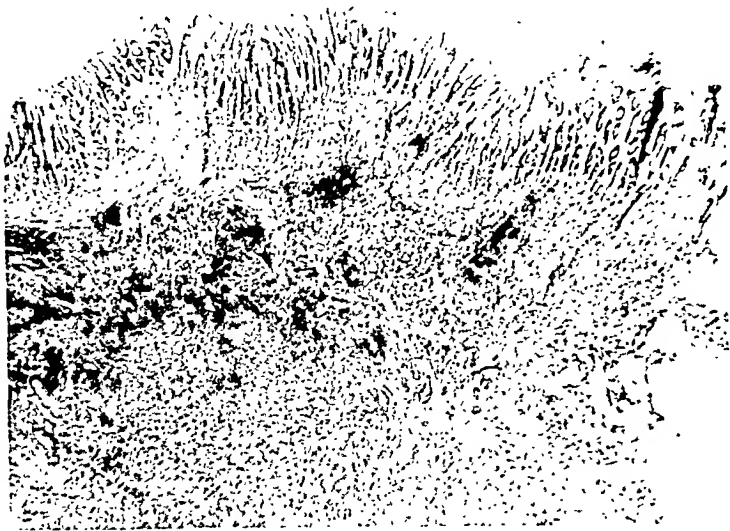


FIG. 7.—Case III.

diameter, which give no gross evidence of being involved. One smaller node is found along the lesser curvature. A segment of colon 8 cm. long shows no gross involvement."

Microscopic examination showed the tumor to be made up of closely packed alveolar strands of deeply staining epithelial cells, many of which showed mitosis. Sections from the lymph-nodes and portion of colon showed no involvement.

Diagnosis: "Carcinoma of the stomach."

It is now five and one-half years since operation, and the patient is free of symptoms, except for the occasional belching of gas. She weighs thirteen pounds more than six years ago. She is a widow with seven children, of whom the oldest is fifteen and

the youngest seven years. Her activities and responsibilities are proportionate.

Physical examination shows that there is slight diastasis of the recti, with no bulge. An X-ray about five years after operation showed a normally functioning gastrojejunostomy. An X-ray of the spine five and one-half years after operation showed no evidence of metastasis.

(No. III.) J. S. (A patient of Doctor Whipple's.) Male, aged fifty-nine years. No. 49,427. Sixty-eight months after operation.

The patient was admitted to the hospital, March 14, 1921, complaining of cramps in the abdomen for about one year, coming on one hour after eating, and disappearing spontaneously. He had lost about five pounds in the one year. No abdominal mass was noted upon examination.

X-ray revealed a filling

defect in the middle third of the greater curvature. There was no retention.

At operation, Doctor Whipple found "a dense, hard, infiltrating mass, involving both anterior and posterior walls of the stomach. It was freely movable and gave the impression of lending itself readily to excision. But after the vessels along the greater and lesser curvatures had been ligated, and the pylorus resected, it was found that the posterior wall at its lower border was adherent to the mesocolon to the left of the colica-media vessels, so that it was necessary to excise a portion of the mesocolon. Fortunately this involved no large vessel. The liver appeared negative. Hard nodes were found along the lesser curvature. A resection with Moynihan technic was carried out."

Pathological report was "adenocarcinoma of the stomach." Sections of lymph-nodes were negative.

The post-operative course was uneventful. Doctor Whipple's final note was to the effect that in this case the "prognosis was poor."

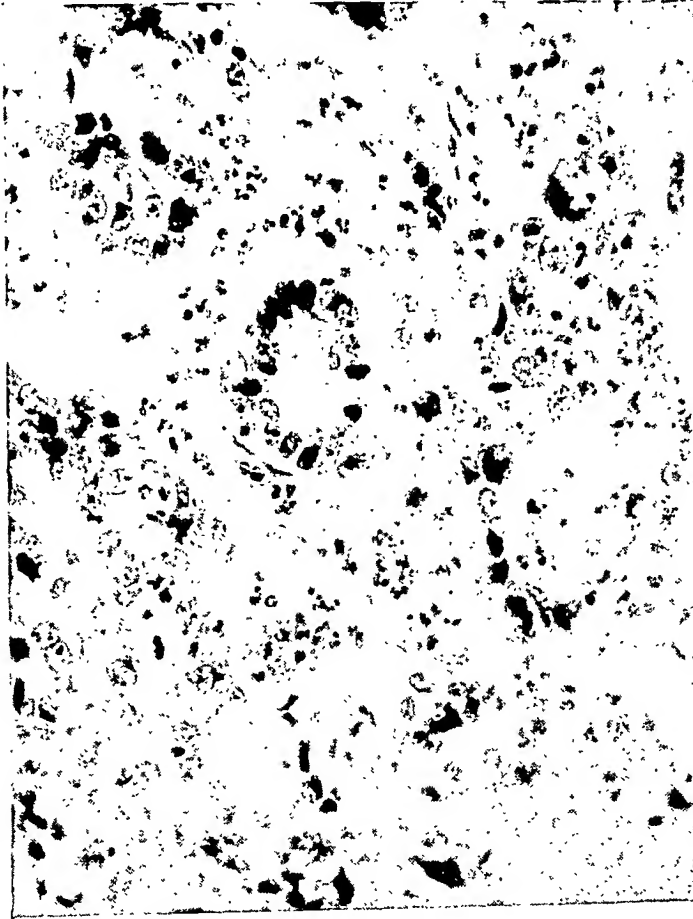


FIG. 8.—Case III.

## SURGICAL RESULTS IN STOMACH CANCER

X-ray two years after operation gave no evidence of anything suggesting recurrence, and X-ray of the chest, four years after operation, was negative.

It is now five years and eight months since operation, and the patient is symptom-free, working as a porter in a ferry-house. Appetite is excellent, bowels regular. He presents a post-operative hernia which permits a more accurate examination of the gastric area. There seems to be no evidence whatever of recurrence.

(No. IV.) F. H. (A patient of Doctor Lambert's.) Male, fifty-five years of age. No. 31,857. Seventy-one months after operation.

This patient was admitted to the hospital in December, 1920; complaining of "pain in the stomach" immediately after eating, during the previous four months. He had lost twenty-five pounds during this period. No abdominal mass was noted.

X-ray showed a six-hour gastric retention, with deformity of the lesser curvature in the pre-pyloric region.

At operation, Doctor Lambert found a mass measuring 5 x 3 cm., oval in shape, involving the pylorus. It was not very hard, and the peritoneal surface showed no special scarring or thickening. The mass was freely movable, and no enlarged lymph-

nodes could be felt in the omentum. A partial gastrectomy, with a Polya-Balfour end-to-side anastomosis was done, with an entero-enterostomy.

Pathological report was "adenocarcinoma, ulcerating"

The post-operative course was uneventful, except for pain after eating, fluoroscopic examination revealing some obstruction to the emptying of the stomach.

A gastro-intestinal X-ray, five and one-half years after the operation, shows a normally functioning gastro-jejunoscopy, with no evi-

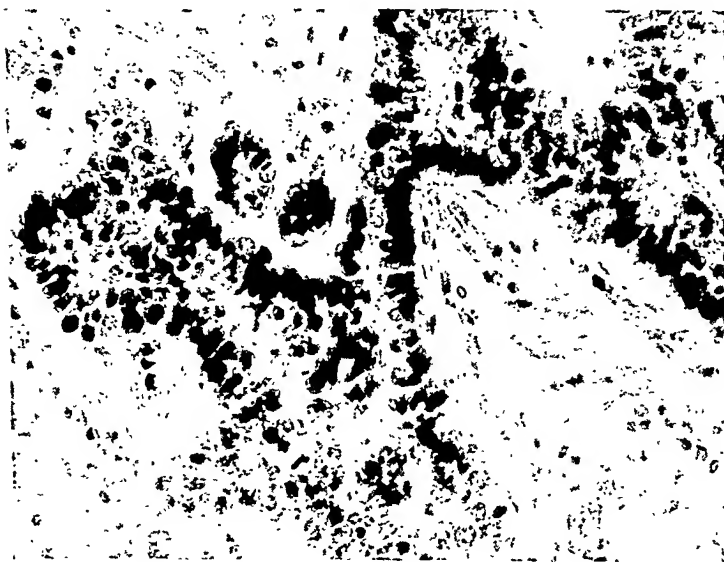


FIG. 10.—Case IV.

dence of recurrence. At present—six years after operation, lacking nine days—the patient is without symptoms, except that he has found a large amount of food is best not eaten at one time. The abdominal scar is firm and there is no evidence of recurrence. He has gained weight.

(No. V.) G. A. (A patient of Doctor Lambert's.) Male, fifty years of age. No. 42,856. Eighty-seven months after operation.



FIG. 9.—Case IV.

The patient was admitted to the hospital in August, 1919, complaining of "hunger pains," "gas on the stomach," and "eructations." There had been a loss of weight of ten pounds in three months.

X-ray showed a large filling defect of the lesser curvature, extending from the mid-portion of the pars media to the pylorus. There was a large gastric retention.

A hard, firm mass, measuring about 4 cm. in diameter, was palpable in the abdomen to the left of the umbilicus. It was freely movable.

At operation, Doctor Lambert found "a large, horseshoe-shaped tumor on the lesser curvature of the stomach, about 2 cm. from the pylorus. The mass was perhaps 5 cm. in diameter. There were some hard, shotty

glands in the gastro-hepatic omentum, and there were other glands in the great omentum, near the head of the pancreas. These were free and not matted together. There were no adhesions of the stomach to any other organ, and the liver and pancreas did not appear to be involved. A resection of the Billroth No. 2 type was performed.

Pathological report was as follows: "Upon opening the stomach by a longitudinal incision, adjacent to the greater curvature, there is revealed a large, cauliflower-like growth measuring 5 cm. x 8 cm. The tissue of which it is composed tends to be friable, and its surface appears ulcerated. The greater omentum contains several enlarged lymph-nodes, which are hard and white." Microscopic report shows "a very extensive and irregular proliferation of atypical glands throughout the entire section. The cells are large, deeply chromatic, and show many mitoses." Diagnosis: "Adenocarcinoma of the stomach."

The post-operative course was uneventful.

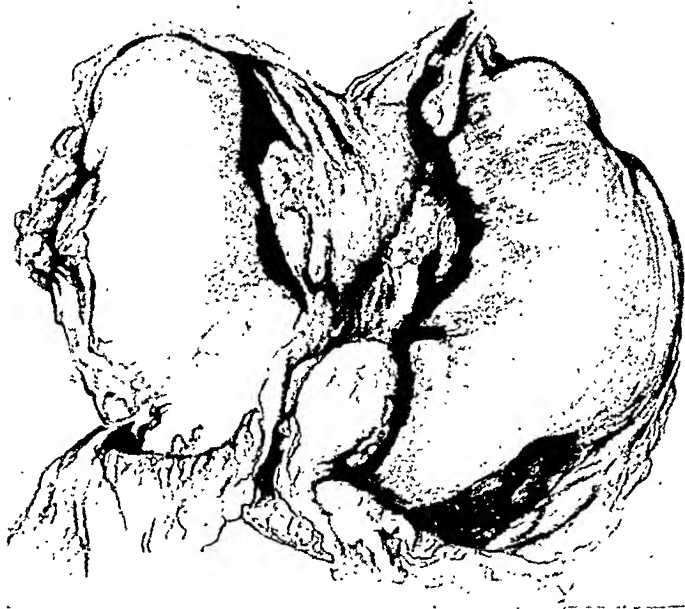


FIG. 11.—Case V.

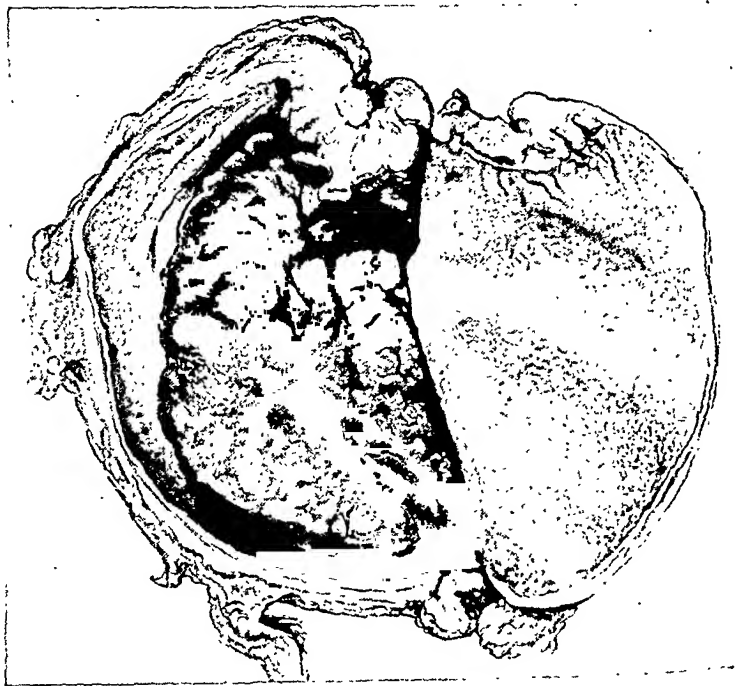


FIG. 12.—Case V.

## SURGICAL RESULTS IN STOMACH CANCER

A gastro-intestinal X-ray, four and one-half years after operation, showed no gastric residue and a normally functioning gastro-jejunostomy.

To-day, seven years and three months after operation, the patient's weight remains unchanged and he is symptom-free. He works from eight to five daily at his usual occupation. Physical examination reveals a well-healed scar, with no evidence of further trouble.

The author is indebted to Dr. A. P. Stout of the Surgical Pathological Service for the use of the photographs of gross and microscopic study of the

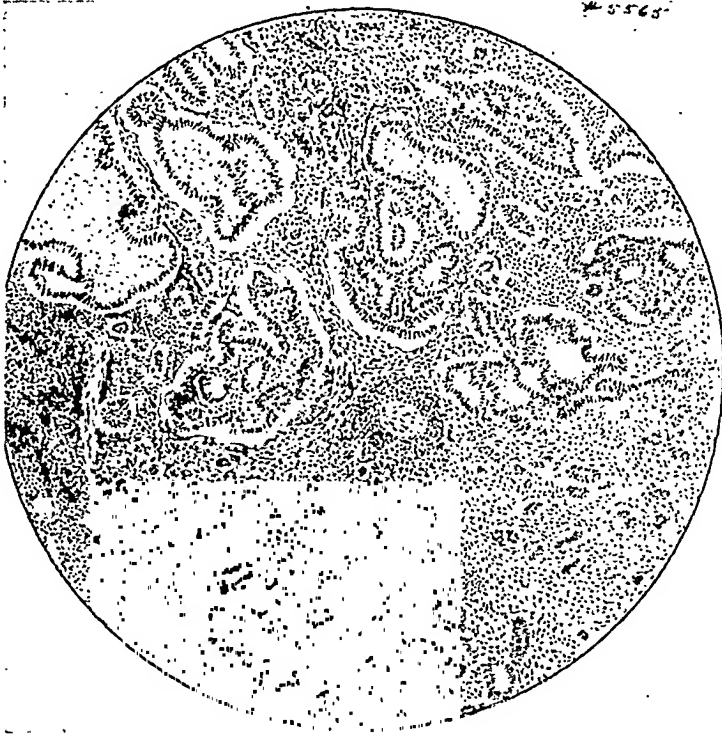


FIG. 13.—Case V.

specimens in connection with the cases shown. He is also indebted to Dr. W. C. Von Glahn of the Pathological Service for the opportunity of including the autopsy analysis incorporated in the article.

# BENIGN STRICTURE OF THE BILE DUCTS\*

BY ROBERT T. MILLER, JR., M.D.

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AS SURGICAL experience grows and the information gained during the management of large groups of cases is made available, it becomes increasingly evident that benign stricture of the extra-hepatic bile ducts is rather more than a surgical curiosity. It is a lesion of unsuspected frequency of occurrence, although, as study of the literature suggests, perhaps encountered most frequently as an unexpected finding at operation. There is now at hand, however, a considerable fund of information concerning the various forms of benign stricture as well as records of experiences in the management of a surprisingly large number of cases, so that it is no longer necessary for the surgeon to rely solely upon a hasty decision made under pressure in an effort to solve a problem altogether new. Among the reports and discussions to be found in the literature, those of Eliot, Judd, Mathieu, Delbet and Lafourcade are worthy of note.

Strictures which are the direct consequence of operative trauma are reasonably well understood so far as concerns their cause, prevention and diagnosis. However, these three phases of the other benign strictures are rather obscure, the opinions found in the literature being largely expressions of conjecture rather than of demonstrated fact, and so far as surgical management is concerned, any variety of the condition may well tax the operator's ingenuity to the utmost. Many of those of widest experience feel that the operative problem offered by these cases is among the most difficult in surgery. In view, then, of the increasingly frequent recognition of this lesion, the possibility that its incidence may be increasing as well, and the paucity of knowledge concerning it, personal experience with the disease should be put on record.

During the winter of 1925-1926, through the courtesy of Dr. Charles R. Austrian, there came under my observation the following instance of benign stricture, an isolated case of sufficient interest to warrant report.

The patient is a physician, aged forty years. His past history includes the usual infectious diseases of childhood, a possible though doubtful attack of typhoid fever of four weeks' duration occurring fourteen years before his present illness, and, while serving in the army, an attack of influenza which was followed by a bothersome productive cough, lasting four or five weeks. He has had recurrent infections of one antrum of Highmore. His habits have been particularly good, there being no question of venereal disease or of the use of either tobacco or alcohol. His present illness started five months ago with a sudden attack of exceedingly severe abdominal colic. The pain, which lasted two hours, was localized in an area about three inches in diameter just to the left of the xyphoid cartilage. The following day his upper abdomen was tender

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\* Read before the American Surgical Association, May 13, 1927.



## BENIGN STRICTURE OF THE BILE DUCTS

and the colic was followed by a persistent dull ache. There was considerable general malaise for a day, but active catharsis brought about prompt recovery and he was himself again in two or three days. During the next three months there were five recurrences of a similar nature, the first two of extreme severity and the final three rather milder. The third attack, the most severe of all, was accompanied by pain in the back, vomiting and severe, persistent, general malaise. None of the attacks bore apparent relation to meals or to the kind of food taken. They occurred invariably about the middle of the night and were preceded for about one hour by a feeling of vague abdominal discomfort. For the two months preceding his admission to the hospital, though there was no severe pain, he nevertheless suffered recurring milder attacks of the same general character, increasing flatulence with regurgitation of sour material several hours after meals, and toward the end of this period was nauseated and generally miserable almost constantly. Definite jaundice made its appearance only during the final three weeks before admission; during this time his stools alternated between an acholic and a well-colored state, though without attacks of pain in any way suggesting a stone in the common duct. Although repeatedly observed, the blood never showed a leucocytosis though the proportion of eosinophiles was increased, varying between 15 and 30 per cent. Fifteen pounds in weight were lost in the last three months.

On examination there is found a well-nourished man who shows a distinct though not deep jaundice, both the sclera and the skin over the entire body being distinctly yellowish. The chest is negative. The abdomen is symmetrical and moderately full, with respiratory motions unrestricted and equal upon the two sides. The liver is felt about 8 cm. below the right costal margin, its edge being quite soft, sharp and not tender. There is no tenderness or muscle spasm in the right upper quadrant or elsewhere in the abdomen. The spleen and the kidneys are not palpable. In the right lower quadrant is the scar of an uneventful appendectomy made a number of years ago.

Blood count: Hæmoglobin, 93 per cent.; red blood corpuscles, 4,816,000; white blood corpuscles, 8350.

Coagulation time, 8 minutes; bleeding time, 5 seconds.

Wassermann reaction negative.

Gastric analysis: Free acid 55, combined 17, total 72; lactic acid negative; guaiac test negative; no Oppler-Boas bacilli or sarcinæ.

Bismuth meal: Gastro-intestinal tract is negative except for the possible presence of a few adhesions in the right lower quadrant.

Röntgenogram of the gall-bladder is negative for gall-stones.

Urine examination: Amber; specific gravity, 1014; acid reaction. Bile + +. Otherwise negative.

The phthalein test for renal function shows the excretion of 40 per cent. in two hours.

Blood chemistry: Blood non-protein nitrogen, 33 hgn. per 100 c.c.; blood sugar, 0.130 per cent.

Examination of the stool: Contains a little bile though in the main is quite clay-like in appearance; there is much undigested food and fat, a little mucus and no parasites. The Schmidt test for bilirubin and biliverdin is negative. Guaiac test for blood negative.

Diastase test: Dilution from 0.1 c.c. of fæces to 1.5 c.c. shows a progressively increasing amount of digestion; dilution from 1.5 c.c. to 4 c.c. shows complete digestion.

We have, then, a patient, aged forty, who for five months has had recurring attacks of upper abdominal colic, sometimes of great severity. The attacks, usually preceded by an hour's discomfort, are associated with nausea, occasionally with vomiting, and followed by malaise which lasts two to three days. The latter part of the illness has been marked by increasing digestive trouble, loss of weight and finally by the appearance of jaundice. While under observation the temperature varied between 97.6° and 99.2°, the leucocyte count was not increased and laboratory tests were largely negative. There was a moderate degree of jaundice with bile in the urine. The only abdominal sign was

a palpable liver edge 8 cm. below the costal margin. Definite abdominal tenderness was not found during the seven days of observation. The condition was thought to be common duct obstruction due either to gall-stones or neoplasm. Among the several men who saw this patient, none expressed a more definite opinion. In order to present only the objective evidence obtained during laparotomy, the note made immediately after operation is quoted verbatim:

*Right rectus incision.* Gall-bladder slightly enlarged, walls markedly thickened; a few adhesions, which were divided. No stones palpated in the gall-bladder. On palpation of the common duct, it suggested a superficial saphenous vein occluded by organized clots. The whole duct was distinctly felt as a hard, clearly defined affair, of a little less than normal size, and it apparently contained a succession of hard objects which were assumed to be stones. The duct was opened; its wall was found to be greatly thickened throughout, its lumen much diminished in size, and lying in it were a few flakes of deeply colored, soft debris, apparently inspissated mucus. No bile came from the duct until a probe had been somewhat forcibly inserted into the hepatic duct, whereupon a small amount of very faintly colored secretion appeared. It was impossible to pass anything larger than a very fine probe into the duodenum, the lumen of the duct being all but occluded by its thickened wall. The exact nature of the change in the wall of the duct was not understood, but because of bothersome bleeding no specimen was excised for diagnosis. The duct was fairly accurately closed with interrupted silk, and cholecyst-gastrostomy was made by a running continuous black silk stitch posteriorly with anteriorly two layers, the first mattress and the second of continuous black silk. The wound was then closed in layers with two cigarette drains reaching to the common duct.

Operation lasted something over two hours; the patient left the table in good condition.

The first two post-operative days passed without notable incident but were followed by an abrupt change in the patient's condition, which became exceedingly critical. He vomited copious amounts of bloody material and passed blood per rectum. He was transfused in all seven times, receiving over 3000 c.c. of citrated blood. After the seventh transfusion the bleeding, which was assumed to be due to jaundice, stopped, and from this time his improvement was steady and reasonably rapid. On the twelfth day after operation examination of the stool showed the presence of bile, tests up to that time being uncertain because of the blood in the gastro-intestinal tract. Sixteen days after operation the wound was completely healed and jaundice was rapidly subsiding. When discharged at the end of five weeks there was no evidence of jaundice externally, though the urine still showed a slight trace of bile. He still complained slightly of mild abdominal discomfort which was relieved by soda. Convalescence was purposely prolonged, but in three months he had largely regained his weight and strength and was apparently in good health. A year after operation the patient had a severe attack of influenza which was followed by a return of the original symptoms of upper abdominal colic, indigestion and mild jaundice at irregular intervals, and he was again losing weight. His condition, however, was in no way comparable in severity to that of the previous year, and it was thought an explanation might be found in the state of relative exhaustion into which he had again allowed hard work to put him.

The case is an instance of stenosis of the common duct in its entire length. The cause of the condition is quite obscure. To refer to spontaneous occurrence explains nothing. Trauma is not a factor inasmuch as the biliary ducts had never been previously exposed. At operation there was no evidence of gall-stones or "sand."

Adhesions about the gall-bladder and thickening of its wall, both of which were found in this case, are certain evidences of inflammation. Inflammation

of the gall-bladder frequently leads to the formation of gall-stones, but this is neither a constant nor an inevitable result. The relation between cholecystitis and calculus is in a way analogous to that between typhoid fever and intestinal perforation: the one is a frequent but not a certain sequence of the other. It is entirely possible—it seems indeed altogether probable—that this patient's biliary tract had never contained a gall-stone. For the purpose of argument, however, let us assume the former presence of gall-stones; it is difficult to understand how the irritation or trauma of a calculus could be so generally and equally distributed as to result in such an extreme fibrosis distributed uniformly throughout the entire length of the common duct. Furthermore, stones of sufficient size and irregularity to cause so marked an alteration in its wall would have no chance of escape from such a duct as was disclosed at operation, or even from a normal duct; and yet neither in my case nor in two similar cases cited later in this paper were stones found. Finally there is the fact that the duct stricture associated with and obviously due to a stone is typically a linear or quite narrow circumferential scar, a quite different thing from general fibrosis. In view of these facts it would not appear sound reasoning to assume the presence of stones and their causal relation to the demonstrated lesion simply because of upper abdominal pain, particularly since the attacks of pain were by no means typical of common duct colic. There is therefore reasonably good evidence that this lesion, diffuse stenosis of the common duct due to extreme fibrosis uniformly distributed throughout its wall, characterizes a distinct group of benign strictures which is quite apart from either the group due to trauma or that due to stone.

There are two general groups of benign strictures of the extra-hepatic biliary ducts, viz., congenital and acquired. Permanent jaundice appearing soon after birth is all but pathognomonic of the first-mentioned group, though very occasionally, as in the case of Treves and certain others, it may not appear before practically adult life. There is a wide variety of anomalies, well described in several excellent papers, notable among them being those of Holmes and Milne; suffice it here to say that the commonest is a localized stricture at the ampulla. Although there is normally at this point in the duct a narrowing which in an infant is extreme, the exact cause of its conversion into a pathological stricture is obscure. The conventional suggestion that it is due to toxic material in the mother's blood seems of doubtful value in view of a report from England made in 1914 by Feldman, who found congenital obliteration of the common duct in one only of a pair of twins. Jaundice appeared at the end of three weeks and the patient died nine weeks later. His brother was perfectly healthy. Were prenatal absorption of toxins from the mother the cause of congenital stricture, it is not clear why but one of a pair of twins should be affected.

Acquired strictures of the extra-hepatic biliary ducts are for the most part not of such obscure origin. Two groups are recognized, the first due to trauma and the second to gall-stones. The injury resulting in stricture of the common duct has usually occurred during removal of the gall-bladder. A

shrunk, fibrosed gall-bladder buried in adhesions and tucked well up under the edge of a liver which cannot be drawn into the wound may well try any surgeon's ability. Not only is exposure difficult, but the finer anatomy is frequently so obscured by inflammatory changes that recognition of the cystic artery is uncertain, if not indeed impossible. It appears that the common duct has been injured most frequently during efforts to control hemorrhage. In a deep field, obscured by blood, attempts to clamp a bleeding cystic artery buried in adhesions are necessarily fraught with hazard; anomalies in the anatomy of the cystic artery and the cystic duct may enhance the difficulty. Such a situation demands accurate work carried out under exact visual control. The duct may be injured unwittingly, the first intimation of misfortune being the failure of jaundice to clear promptly or the persistence of a biliary fistul. As discussion of this matter grows more current, one finds an increasing tendency on the part of those of experience to warn urgently against blind operating. If one identifies the cystic duct, the common duct and the cystic artery, cholecystectomy may be carried out as an exact procedure without danger of injury to the common duct. If inflammatory changes prevent accurate identification of these structures, one may still insure safety in the majority of instances by careful inspection of the tissue to be divided before applying the clamp. This no doubt prolongs the operation a little but an additional few minutes under ether is as nothing when weighed against the lot of one whose common duct has been gravely injured.

In contrast to the traumatic group of strictures stand those due to gall-stones and usually spoken of as inflammatory. These are typically local lesions quite limited in extent, and may occur anywhere along the common duct, most frequently perhaps in its lower portion. The stricture usually involves but a narrow circumferential area, the condition of the rest of the duct being such as to offer some chance of successful repair. It is assumed that they result directly from traumatism of the mucosal surface by gall-stones: an assumption which seems entirely reasonable in view of the frequency with which stones are found at or near the site of stricture. The stricture is really a contracture of the scar tissue caused by the ulcer, itself in turn the result of injury by a calculus. At times there is also a redundant fold of mucosa acting more or less as a valve. Delageniere has described a case in which two stones were caught in the common duct, the lower, impacted near the ampulla, being almost completely covered on its hepatic side by a diaphragm of mucosa with a tiny central opening; after splitting this diaphragm the stone was displaced upward into an accessible part of the duct whence it was removed. Others have described such valve-like folds of mucosa. The so-called inflammatory strictures, then, appear to be characterized by their almost linear character, the limited extent of involvement of the duct which is elsewhere relatively normal, their frequent association with gall-stones and occasionally with valve-like folds of mucosa.

There remains finally for consideration that type of stricture in the production of which trauma plays no part and of which gall-stones presumably

are not the cause, a group illustrated by the case presented in this paper. The essential change is a diffuse, uniformly distributed fibrosis of the wall of the common duct resulting in compression and narrowing of its lumen to the point of all but complete occlusion. A considerable portion of the total length of the duct is involved, perhaps most frequently the entire common duct, and at times the process may extend up into the hepatic duct. It is apparently a more or less uniform change throughout the wall of the entire involved area. Such a duct on palpation resembles a hard, cord-like mass. In the case described above, it suggested a thick-walled vein enclosing a number of organized thrombi. The transverse dimension of the duct was rather smaller than normal, and upon opening it one was immediately impressed with the thickness and toughness of the wall. The edges of the opened duct everted in most striking fashion and it was evident that the lumen had been all but completely obliterated by compression throughout its entire length. There was no point at which the change seemed to be exaggerated above that found elsewhere.

Two cases, almost exact counterparts of my case, have recently been reported by Delbet and Lafourcade. The first, that of Delbet, concerns a man of forty-eight who for two years had recurring attacks of epigastric pain, usually appearing shortly after eating and sometimes associated with vomiting. The pain at times radiated to his back. Jaundice, though not of extreme degree, appeared but twelve days before admission to the hospital. On examination there was found extreme tenderness in the epigastrium, marked spasm of the right rectus muscle, definite jaundice and stools which were largely but not completely decolorized. His temperature was  $38^{\circ}$ , the estimation of amylase normal and the Wassermann reaction negative. Delbet considered the condition a stone in the common duct. At operation there was found, buried in light adhesions, a thin-walled gall-bladder which was slightly distended and contained bile. In the right border of the lesser omentum there was found a dark cord the size of one's "little finger," which was assumed to be the dilated common duct. This was punctured with a hypodermic needle and though no bile entered the syringe, a tiny bit escaped through the wound, making recognition of the duct positive. Delbet incised the cord little by little, traversing many fibrous layers, and finally opened a common duct with extremely thick walls and very small lumen. He was then able without great difficulty to pass a very fine catheter through the lower end of the duct into the duodenum. The catheter could not be passed toward the liver but he nevertheless judged that the duct was not completely occluded since "I found a little bile above." Because of the extensive change in the common duct, the impossibility of forcibly dilating it and the difficulty of repairing the opening which he had made, Delbet concluded the operation by anastomosing the gall-bladder to the duodenum, a logical manoeuvre in view of the presence of bile in the gall-bladder. No gall-stones were encountered during the operation. Convalescence was without incident and jaundice rapidly disappeared. The escape of a considerable quantity of bile from the wound demonstrated clearly that the biliary passages above the incision in the common duct were not completely obliterated. Delbet exhibited his patient in good health a month after operation, and remarked, "How does the bile pass into the gut? Is it by the common duct or the cholecystoduodenostomy or both? I see no means of knowing."

Lafourcade in 1925 reported two benign strictures of the common duct, with the second only of which we are concerned here. His patient was a man of fifty-eight, who for thirty years had had repeated attacks of "hepatic colic." Jaundice, which had never been extreme, became much more pronounced seven months before admission. When

the patient, greatly weakened by the long illness, applied for treatment, he was deeply jaundiced and had clay-colored stools as well as bile in the urine. The liver edge was felt four finger-breadths below the right costal margin. Lafourcade thought it a case of common duct stone. At operation there was found a gall-bladder much reduced in size and buried in adhesions which were widespread over the inferior surface of the liver. The common duct was extremely indurated throughout its entire length and when opened the wall was seen to be markedly fibrosed and greatly thickened. Exploration was thorough inasmuch as during the course of it the duodenum was mobilized and reflected toward the midline. The author specifies that the wall of the duct was  $\frac{1}{2}$  cm. in thickness and its lumen so reduced in size that a stylette could be inserted only with difficulty. The hepatic duct was apparently not greatly changed, for Lafourcade divided it and inserted a rubber tube whose distal end was carried into the duodenum through its posterior wall. In spite of the great decrease of jaundice, death occurred forty-eight hours later. Unfortunately, no autopsy is reported. It is noteworthy that no stones were found in the biliary tract in this case.

These three cases may be regarded as representative of a distinct group of benign strictures characterized by extreme fibrous thickening in the wall of the common duct throughout its entire length, resulting in great diminution of the lumen and obstructive jaundice. Each case showed chronic inflammation of the gall-bladder, but in none were gall-stones found. The change in the wall of the common duct is surely the result of inflammation, but there is no obvious explanation of its strikingly localized character. Objections to the idea that the lesion results from the irritation and traumata of gall-stones were pointed out above. These factors are concerned in the production of limited localized strictures but can scarcely be the cause of so diffuse and uniform an alteration as is described. Both gall-stones and fibrosis are the result of inflammation of the extrahepatic biliary system. The tissue change is usually maximum in the wall of the gall-bladder but under conditions as yet obscure, the wall of the common and hepatic ducts may be altered in quite the same way. At times it seems the pathological alteration may be almost limited to the common and hepatic ducts with little more than a relatively minor change in the gall-bladder; when such a process of fibrosis reaches an extreme degree the inevitable result must be obstructive jaundice.

Eliot remarks that a stricture may develop without the associated operation, and in discussing etiology says: "They may also follow an infectious cholangitis terminating in necrosis of the mucous membrane of the duct, in which event the larger portion of the duct may become stenosed or obliterated." This explanation is hardly applicable to Delbet's case or to mine since so grave a disturbance would undoubtedly be associated with much more severe constitutional symptoms than either case showed. Judd remarks, "Diffuse strictures rarely come to the attention of the surgeon. All extra-hepatic ducts may be involved in the cicatricial process. The condition occurs usually as a congenital arteria of the bile ducts and is most often due to obliterative cholangitis." One may add that although the so-called diffuse stricture due to fibrosis of the wall of the common duct is not common, nevertheless sufficient evidence is now at hand to warrant its recognition as well as to indicate that it is a condition quite apart from congenital or traumatic

stricture and probably quite different in mode of production from the strictures caused by gall-stones. There seems good reason to consider it an inflammatory lesion which results in an essential fibrosis of the wall of the common duct. Neither traumatism nor gall-stones appear to be a factor in its causation. It is then in a sense to be regarded as a type of cholangitis.

There seems to be nothing distinctive in the clinical history of such cases. They come to operation as common duct obstructions the cause of which is assumed to be a stone or a neoplasm. In Delbet's case jaundice appeared only during the final twelve days of an illness of two years' duration, and in my case only during the final three weeks of a five months' illness. Eliot has remarked that "the stricture must be far advanced before the resulting stenosis without associated inflammation will be sufficient to cause jaundice." These facts suggest that marked delay in the appearance of jaundice in a long-standing history of recurring attacks of hepatic colic may possibly prove to be a feature of some importance in diagnosis. Until more is known about the disease, however, its recognition will not be possible before the common duct is exposed at operation.

The purpose of this paper not being a discussion of the surgical management of benign strictures of the bile ducts, suffice it to say that the reported experience with diffuse stenosis of the common duct indicates the wisdom of reëstablishing the current of bile to the intestines by means of cholecyst-gastrostomy or cholecystenterostomy when the state of the gall-bladder and the ducts above permits. There may be added the suggestion that with the common duct occluded, the functional success of such an anastomosis is reasonably well assured even though there remain in the hepatic and cystic ducts nothing more than a meagre lumen. When practicable, it is certainly wise to make this anastomosis, for it offers the hope that drainage so achieved may bring about resolution of the inflammatory tissue and restoration of the lumen of the ducts. Substitution of the ducts by tubes of living tissue or of rubber has not as yet proved of great value.

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# FRACTURES OF THE EXTERNAL CONDYLE OF THE HUMERUS WITH ROTATION

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THERE is in children a characteristic group of fractures of the external condyle with outward rotation of the fragment into an irreducible position. They are infrequent. Their importance rests on the fact of their irreducibility and the consequent indication for treatment, which is preferably in my opinion early open reposition.

Kocher<sup>1</sup> in 1896 reported a successful operation on such a case. Stimson,<sup>2</sup> Cotton,<sup>3</sup> Stone<sup>4</sup> and others have described this type of fracture and its operative treatment. The purpose of this report is to emphasize the fact that these fractures form a characteristic group which should be recognized and appropriately treated. Four personal cases and a fifth, included through the courtesy of Dr. Edward J. Donovan, are presented.

These fractures occur in younger children, the ages varying from five to ten years in this series. The mechanism of production is not explained satisfactorily from any of the histories, several stating that the child fell on his elbow and one that he fell twisting his arm under him.

The fracture line runs from the region of the external epicondyle downward and inward into the joint close to the junction of the capitellum and trochlea, coinciding in part of its extent with the epiphyseal line of the capitellum. The fixed point of attachment is through the external lateral ligament to the radius below. The fractured surface in the typical case is turned outward so that it is subcutaneous, while the articular surface of the capitellum is directed toward the fractured surface of the shaft.

On examination a movable fragment of bone is felt to the outer side of the injured joint. X-ray reveals the displacement but may or may not indicate the rotation of the fragment.

An attempt at closed reduction seems advisable and was made in all the cases here reported. Operation has in each instance demonstrated to the satisfaction of the operator that bloodless reposition was out of the question.

In the experience of the writer, external lateral incision over the fragment gives a satisfactory exposure. Its relations can then be established and it can be turned and pried into place. If a complete reduction of the fragment is accomplished it tends to remain in place and a catgut suture through the periosteum is sufficient fixation together with subsequent immobilization of the joint in a flexed position.

Stimson states that in two of his three operated cases the reduction was accomplished with difficulty. In this series of five cases, the reduction was



## FRACTURES OF EXTERNAL CONDYLE OF HUMERUS

incomplete in one of the writers, the fragment remaining anterior. Most of the failures at reduction will probably be in relatively late cases. It is important, therefore, that the condition be recognized promptly so that operation may be carried out at an early date, preferably by the end of the first week. Stone states that reposition may be done up to about six weeks. It would probably become very difficult before this time was passed.

If reposition is found impossible at operation, or if a patient presents himself with disability after it is too late to hope for reposition, the fragment should be excised. Experience shows that this may be done with a good functional result. It is clearly, however, not the method of choice.

Siris<sup>5</sup> has reported a case of this type treated without operation. A perfect functional result was obtained. There was of course a deformity, which, however, Doctor Siris<sup>6</sup> has found becomes less with passage of time. This deformity to my mind outweighs the risk of an open operative procedure under favorable circumstances.

CASE I.—F. S., eight years old, fell from a window to the ground, landing on the left elbow. (1916.) Examination in the out-patient department revealed a freely movable fragment of bone directly under the skin lateral to the external condyle. The X-ray report was fracture of the external condyle, including the articular facet for the radius, with displacement to the outer side and forward. After unsuccessful attempts at reduction he was admitted to the hospital. Operation was done eight days after injury. A lateral incision was made. The fractured surface was found to be rotated outward and downward. The fragment was replaced and secured by interrupted sutures through periosteum and fascia. The arm was put up in flexion. Examination seven years after operation showed a normal appearing elbow with function completely restored save for two or three degrees limitation in both flexion and extension.

CASE II.—G. F., six years old, fell off a cart twisting the right arm under him. (1919.) Operation three days after injury through lateral incision. The outwardly displaced external condylar fragment, which included the capitellum, was turned so that the fractured surface was subcutaneous. Reduction was thought to be accomplished in this case but the post-operative X-ray showed that the fragment was anterior. The patient was discharged on the forty-first day with flexion to 90 degrees and extension to 140 degrees. It has not been possible to reexamine this boy as he lives out of town. A report from his mother seven years after operation is to the effect that he uses the injured arm as well as the other. Flexion is not complete, extension is nearly so. There is no information as to deformity.



FIG. 1.—Case IV. C. S. Fracture of external condyle with irreducible outward rotation. It seems pretty clear from this X-ray that the fractured surface is outward.

CASE III.—J. S., ten years old, fell, striking the back of his left elbow. (1920.) A bony fragment could be felt displaced forward and laterally from the external condyle. X-ray showed an external condylar fracture involving the capitellum with the fragment completely dislocated away from the humerus. Closed reduction was unsuccessful. Operation through a lateral incision six days after injury. The fragment was rotated outward. It was reduced, secured with periosteal sutures and the arm put up in flexion. Four months after operation it was noted that there was slight limitation of extension remaining. One year later the functional result was perfect.

CASE IV.—C. S., five years old, fell from a cart, striking his right arm. (1923.) On examination a loose bony fragment was felt to the outer side of the external condylar

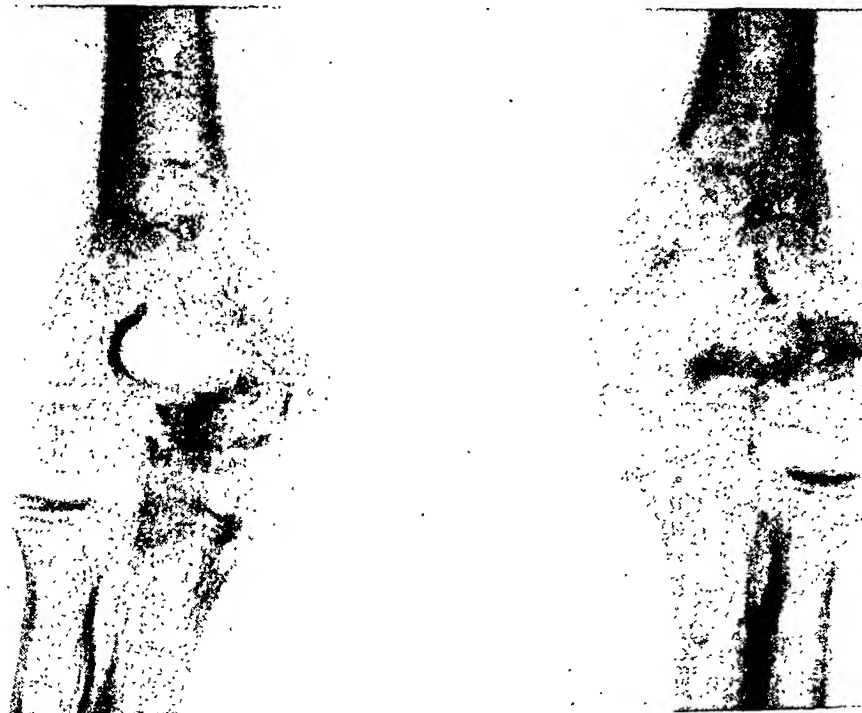


FIG. 2.—Same as Fig. 1, after three years. There is a little alteration of the outline of the lower end of the humerus as a result of the injury. Capitellum is in place and result as to appearance and function perfect.

region. X-ray showed it to be a fracture of the external condyle involving mainly the capitellum. Attempt at closed reduction failed. Operation five days after injury through a lateral incision. The fragment was found with fractured surface rotated outward. It was reduced with some difficulty and secured with sutures. The arm was put up in acute flexion maintained by a starch bandage. The boy was discharged from the hospital on the third day. At a follow-up examination six months later, it was noted that functional recovery was complete.

CASE V.—Doctor Donovan. M. M., seven years old, fell about eight feet, striking his left elbow. (1926.) X-ray showed a laterally displaced fractured external condyle with fractured surface outward. Attempt at reduction was unsuccessful. Operation seven days after injury. Incision in the antecubital space along the medial border of the brachio-radialis. The radial nerve was identified and pulled inward. The fragment was replaced and the periosteum sutured. At the follow-up examination two months later there was a complete return of function.

It is not stated that all irreducible fractures of the external condyle fall into this group. It does seem to the writer, however, that the cases here presented are typical and the recognition of their characteristics important

## FRACTURES OF EXTERNAL CONDYLE OF HUMERUS

because, contrary to the vast majority of fractures in children, the indication for early open operation is clear.

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# FRACTURE OF THE FIFTH METATARSAL BONE\*

WITH SPECIAL REFERENCE TO DELAYED UNION

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TWENTY-ONE cases of fracture of the fifth metatarsal bone will be considered to illustrate a tendency toward delayed union probably caused by poor blood supply. Knowledge of this tendency is necessary for prognosis and treatment.

*History.*—Much has been written concerning fractures of the metatarsals. The interest in their evolutionary history lies in the fact that even to-day such fractures frequently go unrecognized, especially if produced by indirect violence. Cumulative evidence seems to show that writers have been puzzled by the long disability frequently accompanying the comparatively slow healing of fractured metatarsals. The "fussgeschwulst" (foot-œdema) of the Germans was first described by Breithaupt<sup>1</sup> in 1855. He noted that soldiers on the march were frequently disabled by painful, swollen and tender feet, he attributed this condition to strained ligaments and tendons. In 1877, Wiesbach<sup>2</sup> named it "syndesmitis metatarsæ" and in 1884, Laub<sup>3</sup> referred to it as the "periostitis of fatigue." Pauzat<sup>4</sup> in 1887 interpreted this condition as an "osteoplastic periostitis";

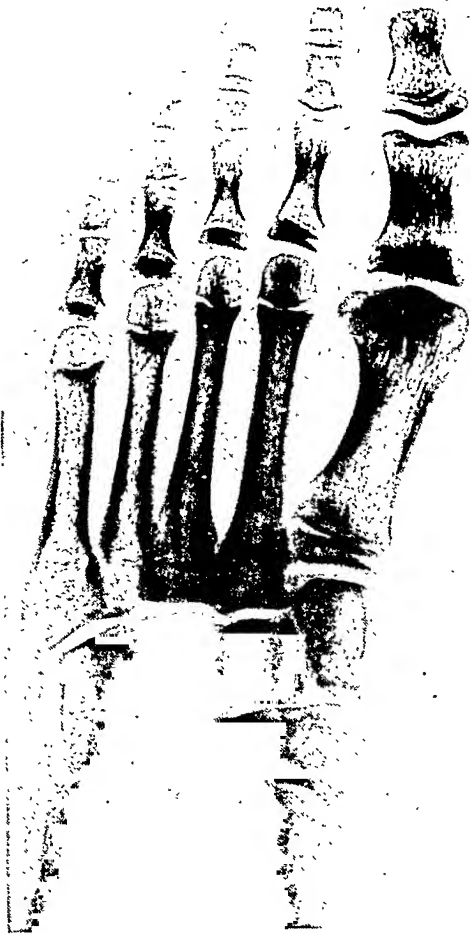


FIG. 1.—Shows the epiphysis of the tuberosity in an eleven-year-old boy.

in 1888, Poulet<sup>5</sup> described it as a "rheumatic osteo-periostitis", and in 1891, it was named "Inflammation periosto-arthritique du Pied" by Martin.<sup>6</sup> Then followed discussions by Rittershausen<sup>7</sup> and by Busquet.<sup>8</sup> It was not, however, until 1897, that Schulte<sup>9</sup> first thought that this condition was a fracture, and in 1898, Kirchner<sup>10</sup> definitely proved this theory by röntgeno-

\* Read before the Orthopædic Section of the New York Academy of Medicine, April 15, 1927.

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gram. Subsequently there have been many articles on the "marching fracture" of the British and Americans, the "pied forcé" of the French, and the "fussgeschwulst" of the Germans. Only recently Murk Jansen<sup>11</sup> has called attention to this condition. He believes that a spasm and pull of the fibres of the interosseous muscles produce either a subperiosteal hemorrhage or a disturbance in circulation to cause the bone thickening seen in the röntgenogram. Meiser<sup>12</sup> found in his statistics that only one-third of fractured metatarsals showed distinct evidence of the lesion in the X-ray picture. He also states that the röntgenogram does not show the formation of callus often before the tenth day and frequently not until three weeks after fracture. Massacr  <sup>13</sup> also stresses the usual delay in bone repair. Weichelt<sup>14</sup> thinks that perfect union rarely can be accomplished in fractured metatarsals, especially when produced by a twist. Graham<sup>15</sup> reports the case of a man of fifty who had a fracture of the base of the fifth metatarsal caused by indirect violence. The first examination, five weeks after the fracture had occurred, showed that no union had taken place. Young<sup>16</sup> had a case of fracture of the distal end of the fifth metatarsal in which non-union was verified by X-ray. Removal of the head of this bone did not relieve the metatarsalgia, but subsequent excision of the head of the adjacent bone produced some relief. All the foregoing facts seem to indicate the validity of the contention that "fussgeschwulst" is most likely due to a fracture of one of the metatarsals. It will later be shown how delayed union in some fractures of the fifth metatarsal could probably explain the picture presented in "fussgeschwulst".

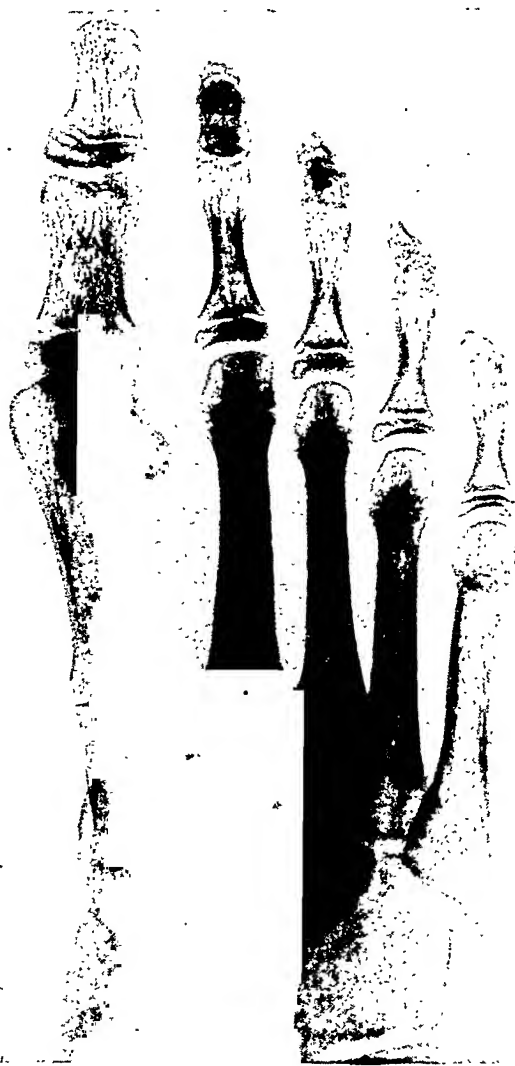


FIG. 2.—The same bone shown in Fig. 1, at fourteen years and three months, to demonstrate the advance in ossification.

Statistics.—It is of interest to note the relative frequency of fracture of the metatarsal bones. In 491 cases, Kirchner<sup>17</sup> found the fractures distributed as follows:

I	II	III	IV	V
0	253 (52%)	198 (40%)	32 (6%)	8 (2%)
	Distal Third	Middle Third		Proximal Third
	52%	42%		6%

TABLE I.  
*Synoptical Table of Twenty-one Cases of Fracture of the Fifth Metatarsal.\**

No.	Age	Sex	Trauma Direct	Site and type of fracture	Weight bearing	Length disability	Laboratory findings	Follow-up	Remarks
149173	25	F	+	Distal end of shaft, transverse, head displaced medially	14 weeks	6 months	Urine—negative Wassermann—negative Blood calcium... 10.04 } mgs. per Blood phosphorous 2.5 } 100 c.c.	Union in about 20 weeks, with some pain and swelling beneath malleolus. At 9½ months slight pain around ankle and swelling beneath malleoli on walking. Slight tenderness at site of fracture	False point motion at 12 weeks. Delayed union.
128576	40	F	+	Base—Transverse—no displacement	9 weeks	6 months	Urine—negative Wassermann—negative. Blood calcium... 9.45 } mgs. per Blood phosphorous 3.8 } 100 c.c.	2½ years. Slight tenderness over site of fracture. Some residual decalcification of metatarsals	Rarefaction of metatarsals predominant in X-ray. Delayed union.
131625	31	M	?	Base—transverse, comminuted	6 weeks	11 weeks	Urine—negative Wassermann—negative Blood calcium... 10.9 } mgs. per Blood phosphorous 3.3 } 100 c.c.	28 months—no symptoms or signs. By X-ray thickening of bone at site of fracture	Delayed union.
130169	34	M	+	Base, complete—no displacement	6 weeks	3 months			Probably delayed union.
120159	34	F	+	Base—no displacement	5 weeks	4 months			Probably delayed union.
117073	24	F	+	Distal end shaft—slight displacement proximal fragment	4 weeks	3 months		4 months—no symptoms or signs	
130590	26	F	?	Base—transverse, no displacement	5 weeks	3 months		6 months—no symptoms or signs	

## FRACTURE OF THE FIFTH METATARSAL BONE

No.	Sex	Age	History	Examination	Roentgen	Pathology	Prognosis	Remarks
142498	F	41	+	Distal end shaft, incomplete, transverse	4 weeks	3 months	Urine—negative Wassermann—negative Blood calcium 10.02 mgs. per 100 c.c. Blood phosphorous 2.54 } 100 c.c.	16 months—no symptoms or signs. X-ray shows firm union
149373	F	56	+	Tuberosity	8 weeks	3 months	Urine—negative Wassermann—negative Blood calcium... 9.55 mgs. per 100 c.c. Blood phosphorous 2.9 }	3 months—considerable oedema dorsum foot—tenderness at site of fracture. X-ray shows moderate amount callus
118592	M	60	+	Base—transverse, no displacement	6 weeks	2 months		13 weeks—no symptoms or signs
143848	F	19	+	Tuberosity	4 weeks	1 1/2 months	Urine—negative Wassermann—negative	1 year—no symptoms or signs
113604	F	46	+	Base—incomplete	2 weeks	5 weeks		3 months—slight swelling about ankle on walking
126070	M	47	+	Base, transverse, lateral displacement distal fragment	22 days	5 weeks		
111749	F	50	+	Base	4 days	4 weeks		
109343	M	35	+	Tuberosity	3 weeks	4 weeks		
17668	M	41	+	Shaft—comminuted, no displacement	2 weeks	2 weeks		
136100	M	41	+	Shaft—middle third, oblique		Did not return		
133746	F	55	+	Shaft—proximal third, oblique		Did not return		
121326	M	20	+	Base—no displacement		Did not return		
115829	F	19	+	Base—transverse		Did not return		
132158	M	13	+	Base, transverse epiphysis tuberosity present		Did not return		

\*The predominating symptoms and signs in all the cases were pain, swelling, ecchymosis, and tenderness. They were immobilized either by a posterior moulded plaster splint for the foot and leg or by a plaster boot. The cases that were followed received physiotherapy at frequent intervals.

Summarizing 233 cases, Nion<sup>18</sup> found the fracture 115 times on the right side and 118 times on the left.

*Anatomy.*—The fifth, the most exposed of the metatarsal bones, is one of the smallest, yet one of the strongest of them all. It develops a separate osseous centre in the distal end between the third and the fifth years, and sometimes as late as the eighth year. Between the eighteenth and the twentieth years the epiphysis unites with the shaft. Kirchner<sup>19</sup> describes a separate epiphysis for the tuberosity, which Gruber<sup>20</sup> believes to be only occasional. On the other hand, Schouwey<sup>21</sup> found it constant and occurring in the thirteenth and fourteenth years. In one specimen that he examined microscopically he was able to demonstrate that the centre of ossification is first developed in the tendon of the peroneus brevis. Figure 1 shows the epiphysis of the tuberosity in a boy of eleven and Fig. 2 shows the advance in ossification in the same bone at fourteen years and three months. The base, tuberosity, shaft and head make up the entire bone. The tuberosity, rather

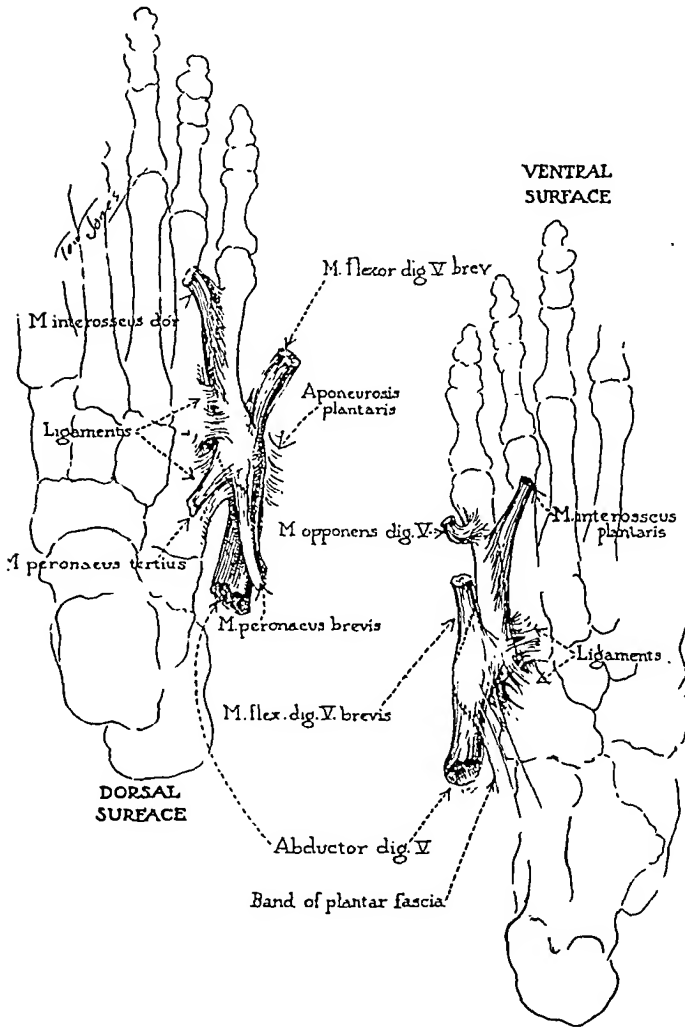


FIG. 3.—The muscle and ligamentous attachments to the fifth metatarsal. (From Christopher<sup>22</sup>.)

prominent and nipple shaped, projects on the lateral aspect of the base, which, by a posterior facet, articulates with the cuboid, and, by a mesial facet, with the fourth metatarsal. The shaft differs from any of the other metatarsals in being compressed from above downward, instead of from side to side, so that it presents superior, inferior and mesial surfaces. The head is small, turned somewhat laterally, and has a pair of lateral tubercles at the end of the dorsal aspect of the shaft. The muscle and ligamentous attachments are shown in Fig. 3.

*Blood Supply.*—Comparison shows that the rate of union in fractured



## FRACTURE OF THE FIFTH METATARSAL BONE

metacarpals is more rapid than that in metatarsals, and that the calibre of the blood-vessels supplying the former is larger than that of the blood-vessels supplying the latter. In addition, weight-bearing tends to compress the branches of the plantar arch. The nutrient vessel of the fifth metatarsal, which, according to Piersol,<sup>22</sup> may be absent, enters by a foramen usually situated on its tibial side, and it is significant that this vessel is as a rule directed toward the base. (Fig. 4.)

It is represented only by a few fine branches which anastomose with the small blood-vessels of the epiphyses. The latter are more abundant than the former. Johnson,<sup>23</sup> in his work on the blood supply of the diaphysis, concludes that the factors essential in bone repair are, in the order of importance, the nutrient artery, and the vascular networks of the metaphysis and of the periosteum.

*Mechanism.*—The mechanism of fractures of the fifth metatarsal is through direct or indirect violence. The exposed position of this bone is a predisposing factor for its injury by direct violence by a blow, a fall, striking the outer side of the foot against a hard immovable object, and by a wheel of a vehicle in motion. The indirect violence is usually a forcible inversion of the foot accompanied by weight-bearing, through a fall, a jump, a sudden step on uneven ground or dancing. Sir Robert Jones<sup>24</sup> fractured the base of his own fifth metatarsal by the last mechanism. A glance at Fig. 5 will show that whereas the proximal end is subject to strain by plantar fascia and a pull of peroneus brevis and tertius, the distal end is acted upon by the dorsal and plantar interossei and the opponens digiti quinti.

An analysis of twenty-one cases given in table shows the following:

1. Sex: Males, 9 (47 per cent.). Females, 12 (53 per cent.). 2. Age: Youngest, 13 years. Oldest, 60 years. Average, 36 years.

		Base	Tuberosity	Shaft	Distal Extremity	Total
3. Violence	{ Direct	..... 3 (38%)	1 (12%)	2 (25%)	2 (25%)	8
	{ Indirect	.... 7 (64%)	2 (18%)	1 (9%)	1 (9%)	11
	{ Doubtful	.... 2 (100%)				2

4. Predominant symptoms and signs—pain, swelling, ecchymosis and tenderness.

5. Length disability (16 cases): Shortest, two weeks. Longest, twenty-four weeks. Average, ten weeks. 6. Females tend to have a longer disability than males. 7. The end results are good.

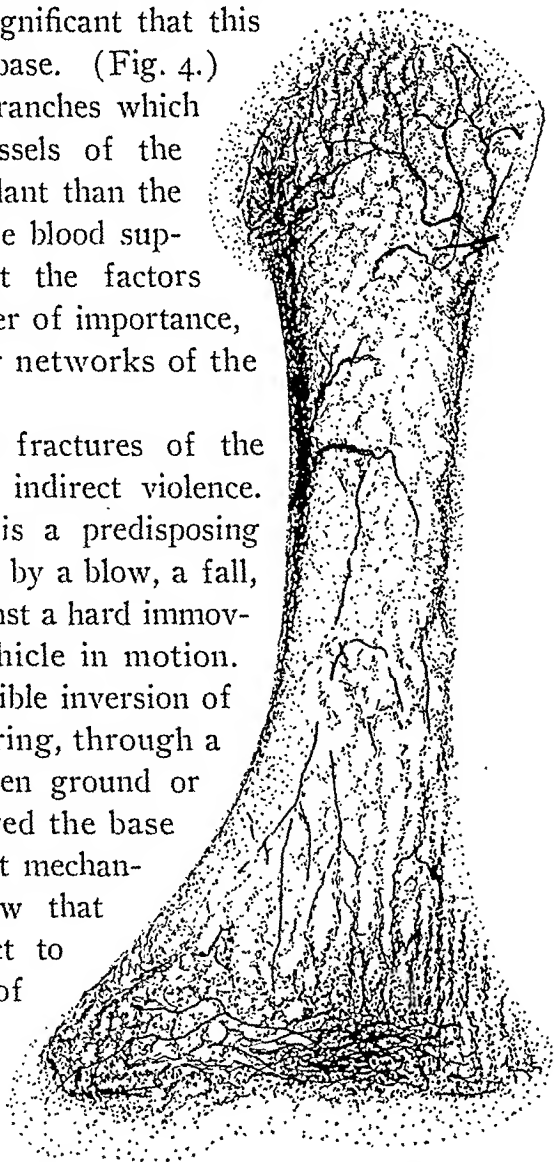


FIG. 4.—The blood supply of the fifth metatarsal. Note the fine primary nutrient vessel and the small blood-vessels of the epiphyses. (From Lëxer<sup>23</sup>.)

A further analysis of the 20 cases in adults shows that there were five cases which from clinical and X-ray evidence had delayed union. This occurred four times at the base and once at the distal extremity of the shaft. All the other cases that could be followed had characteristic pain, tenderness

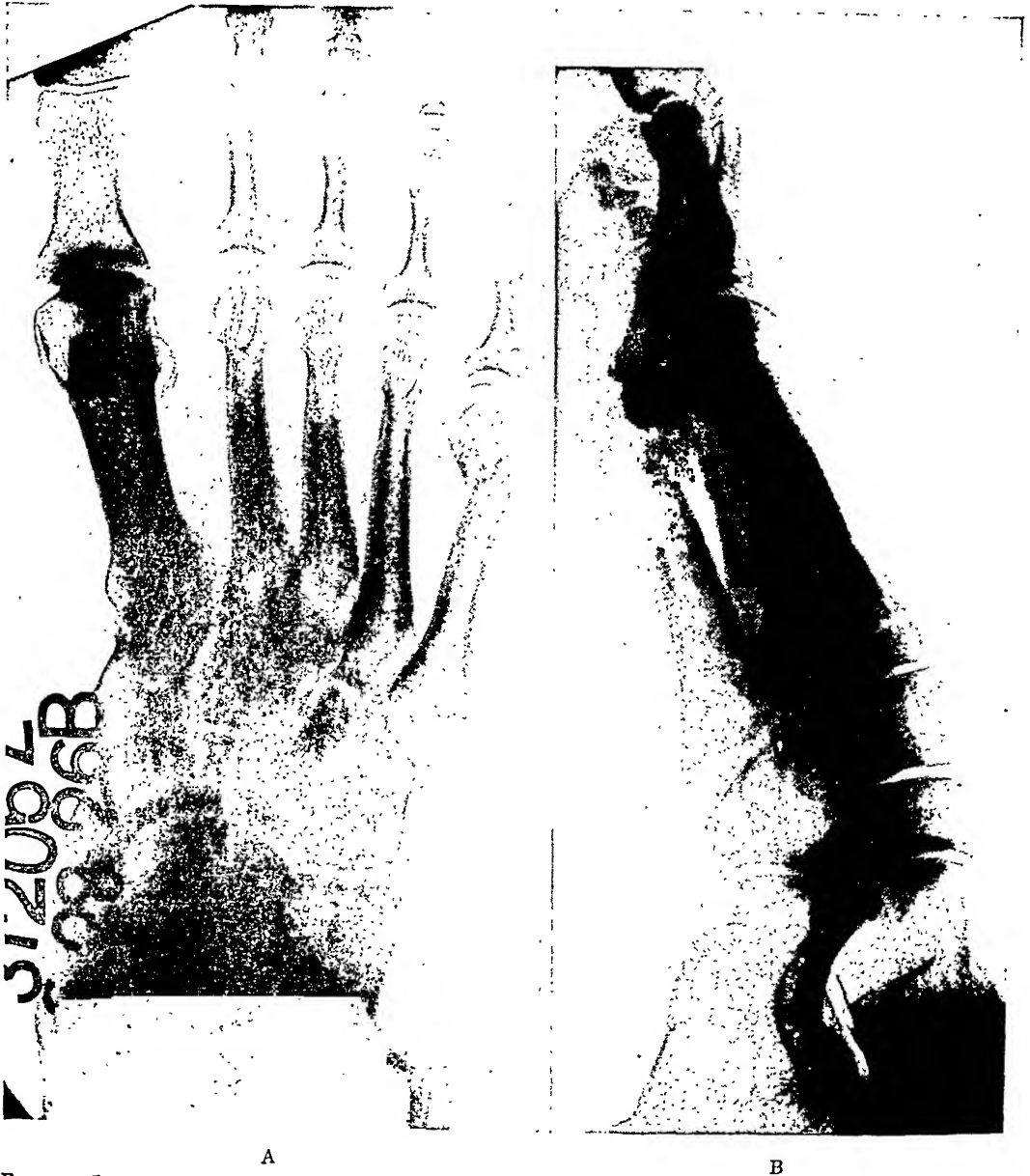


FIG. 5.—Case No. 149,173. To show a fracture of the distal extremity of the shaft of the fifth metatarsal nine days after injury.

and œdema at and surrounding the area of fracture, which extended over periods of weeks or months. While it is true that soft part injury in association with the fracture might produce these symptoms for a short period, still interference with proper bony union is the most plausible explanation for the long disability.

One would expect in a long bone as small as the fifth metatarsal, that enough union would take place in the cancellous portion in about ten days to

prevent mobility of the fragments. In the cortical bone of the shaft, normal calcification should occur in about three weeks. When delayed union occurs, some attempt at repair is being made, but it is slow nevertheless. Estes<sup>25</sup> considers delayed union to have taken place when it becomes evident eight days or more after the upper limit. When union has taken place, abnormal mobility cannot be detected at the site of fracture. This, however, has no relation to the strength of repair. When there is abnormal mobility after six months, non-union is said to have occurred. The relative frequency of delayed union in all bones is variously given by different authors. Nutter<sup>26</sup> quotes Boyd and also Von Bruns, who estimate that it occurs in about  $1\frac{1}{4}$  per cent. of fractured limbs. Hey Groves,<sup>27</sup> however, gives the frequency between four and five per cent. The usual causes for delayed union are, excluding compound and badly comminuted fractures:

1. Circulatory disturbance.
2. Infection.
3. Syphilis.
4. Low calcium and phosphorus content of the blood (Petersen).<sup>28</sup>

It will be seen that all the factors except circulatory disturbance have been eliminated from the group of cases under consideration.

The type of bone repair in fractured metatarsals is rather interesting. Several varieties of callus may be formed.

1. It may be so small as to be scarcely visible in the X-ray. This is especially true when there has been no displacement of fragments.

2. It may be excessive and form the so-called "cal vicieux." This frequently occurs when the fracture has been overlooked and the patient walks about. It may be so large as to impinge on an adjacent metatarsal or cause pressure on the plantar nerves.

3. It may be long and thin, stretching almost the entire length of the shaft.

4. It may be delayed for a long time and then appear quickly or slowly.



FIG. 6.—The same as Fig. 5, after one month. Note the very slight callus on the mesial aspect of the fracture line.

It must be remembered, however, that the time for the appearance of callus in the X-ray is variable. Twenty-two days after fracture of a metatarsal, Kirchner<sup>17</sup> found a thick callus by röntgenogram which could not be easily detected on examination. Thiele<sup>20</sup> found no callus fifteen days after such a fracture, but fifteen days later it was marked. This bears out



FIG. 7A.—The same as Fig. 5, after three months, when false point of motion could still be elicited. Note the slight amount of callus mesially and apparently none laterally. The bones of the foot are rarefied. B. Showing rarefaction of the bones of the foot.

the observation that there may be apparent inactivity in callus formation for several weeks and then calcification may occur quite rapidly.

*Treatment.*—On the basis of all the foregoing facts, the treatment recommended is as follows:

1. Immobilization of the foot and leg by means of a posterior moulded plaster splint. Crutches may be used.
2. Measures such as deep light therapy and gentle massage to promote hyperæmia. These methods are better with the foot in the splint.

# FRACTURE OF THE FIFTH METATARSAL BONE

Fig. 8.—The same as Fig. 5, after six months, showing union.



Fig. 9.—Follow-up roentgenogram of Fig. 5, after nine months showing firm union. Note the thin callus rounded off.



Fig. 10.—Case No. 131625. To show a transverse, comminuted fracture of the base of the fifth metatarsal bone.



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24

3. If there is a tendency to delayed union, the administration of calcium<sup>30</sup> or cod liver oil, heliotherapy, and perhaps scarification of the fractured ends with a needle introduced through the soft parts in order to produce bleeding. The last is recommended by Darrach<sup>31</sup> in some cases of non-union.



FIG. 11.—The same as Fig. 10, after one month. Note that there is only very slight callus formation.



FIG. 12.—The same as Fig. 10, after twenty-eight months, to show perfect union and considerable thickening of the bone at the site of fracture.

4. Avoidance of excessive trauma to demonstrate mobility of the fragments.

*Prognosis.*—This must be guarded as to the time and extent of disability. The best prognosis can be given for fracture of the tuberosity.

*Summary.*—Twenty-one cases of fracture of the fifth metatarsal are reported, with their analysis. Twenty were in adults, and of these five showed clinical and X-ray evidence of delayed union. All the latter had a normal blood calcium and phosphorus and a negative urine and blood Wassermann. All the other cases that could be followed had clinical symptoms over such long periods that it is fair to assume some interference in bone repair. The

## FRACTURE OF THE FIFTH METATARSAL BONE

main cause of this condition is probably the poor blood supply of this bone. The treatment is directed toward immediate immobilization and hyperæmia. The experience from all these cases tends to show that too long immobilization produces bone atrophy which certainly cannot help bone repair. Weight-bearing in a strong moulded plaster splint before one month, where possible, is suggested to overcome this bone atrophy. Between the eleventh and sixteenth years, the epiphysis of the tuberosity is not to be mistaken for fracture.

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## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

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A STUDY OF 361 CASES OPERATED UPON IN THE SERAPHIMER HOSPITAL OF STOCKHOLM, SWEDEN

DR. A. TROELL SURGEON-IN-CHIEF

### SYNOPSIS

- I. Statistical data.
- II. Operative mortality and causes of death.
- III. Methods of operation and abdominal complications.
- IV. Late results.
  - a. Patients dead of relapse within five years after operation.
  - b. Patients dead of relapse later.
  - c. Patients dead of another disease later.
  - d. Patients still alive more than five years after operation.
- V. Methods of operation and late results.
- VI. Cancer types and late results.
- VII. Summary and conclusion.

Forty years have passed since the first gastric resection at the Seraphimer Hospital was performed for cancer ventriculi, the most common of all malignant tumors in human beings.

What, then, have we to learn from forty years' experience at the Seraphimer Hospital with respect to cancer of the stomach, and its treatment? How much better are we now equipped than forty years ago for the recognition and the combating of this crux medicorum? Are the immediate and lasting results still so poor—in spite of the undeniable diagnostic progress made—that we seem obliged to doubt that we are in such a position? This is a question which, *inter alia*, will be dealt with in this paper, as far as a judgment can be reached with the aid of the—quantitatively—not so inconsiderable material obtained at the above-mentioned hospital.

The first gastric resection at the Seraphimer Hospital was performed (by Berg) July 27, 1887. I shall quote literally from the operative record: "The operation was carried out to-day at 11 A.M. in a room which had been aired and cleaned during the summer, and which had been put in order for the occasion. The temperature of the room was 30° C. and a carbolic spray had been going the whole morning . . ." The expressions employed give us some little idea of the development of surgery during the past forty years.

### I. STATISTICAL DATA

The material on which this investigation is based consists of all the operated cases of gastric cancer in the surgical clinics of the Seraphimer Hospital during the period 1887–1926, exclusive of cancer cardiæ. It embraces 361 cases

of resection, 450 cases of gastro-enterostomy, and 339 cases of exploratory laparotomy, *i.e.*, a total of 1150 cases. A number of cases which were not subjected to any operation have not been included, the diagnosis not having been considered as satisfactorily determined, especially during the first few years of the epoch.

Of the 361 resected cases, 260 (72 per cent.) have been submitted to anatomico-pathological examination most regularly during the last twenty years, but the diagnosis, "cancer," with a probability bordering on certainty may be considered as certain in the other cases, too, the histological examination having not been carried out only in those cases of cancer which were

macroscopically certain, even as regards the preparation taken out and examined from the inside.

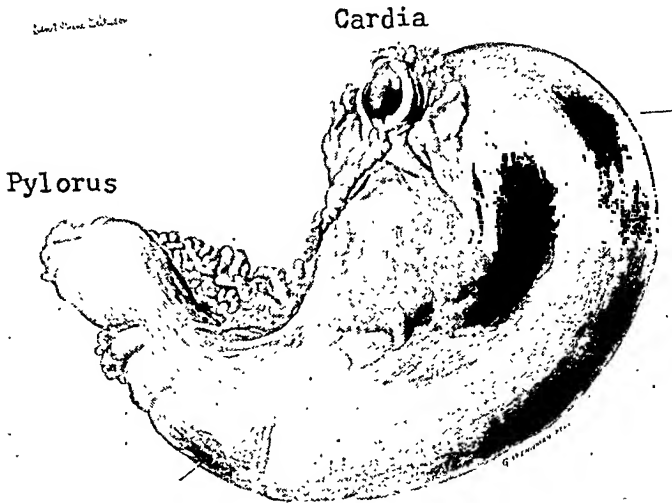


FIG. 1.—Total gastrectomy; drawn from a specimen removed by operation.

Among the cases which have been submitted to gastro-enterostomy, or only to exploratory laparotomy, there have been certainly some instances where cancer did not exist but, instead, ulcer or some other benign affection. Troell<sup>9</sup> has, with respect to a part of this material directly shown, that this is certainly the case, *viz.*, "that diseases assumed

on laparotomy to be certain cancer, may later on, have a course which does not readily permit of our maintaining this diagnosis." Of seventy patients who have been submitted to gastro-enterostomy, and 52 who have undergone exploratory laparotomy for supposed inoperable cancer ventriculi, 5 were still alive without any sign of cancer, six, and even eight years after the operation. It must not be forgotten, however, that all these gastric tumors, which had not been radically operated, had only been examined from the exterior of the stomach at the moment of the operation. As the inoperable cases will be mentioned in this paper only *en passant* (their number, at different periods of time, as compared with that of the resection cases), and as, in addition, we may, perhaps, venture to assume that the frequency of erroneous diagnosis in this direction is distributed about uniformly throughout the whole of the period covered by this investigation, these 4 per cent. may be neglected here; although their existence is, *per se*, of great interest.

Resection has been performed on 210 men, of an average age of, very closely, fifty-four (maximum age seventy-six; minimum twenty-nine), and 151 women, of an average age of, approximately, fifty-two and one-half years (maximum seventy-five; minimum thirty).

The greatest frequency of operable cancer, 35.2 per cent. of all the cases, is found within the age-group fifty to fifty-nine years.

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## II. OPERATIVE MORTALITY AND CAUSES OF DEATH

Of 361 resection cases, 101 (28 per cent.) have died in connection with the operation, or, at all events, in the hospital before they could be discharged. The following table shows the mortality for exploratory laparotomy and gastro-enterostomy too:

Exploratory laparotomy .....	339 cases—17.1% dead
Gastro-enterostomy .....	450 cases—23.1% dead
Resection .....	361 cases—28% dead

For the sake of comparison, there is given a summary from more recent statistics which have been drawn up by Anschütz and Konjetzny, 1921<sup>1</sup>:

	Men	Women
Exploratory laparotomy .....	94 cases—14% dead	45 cases—4% dead
Gastro-enterostomy .....	507 cases—32% dead	314 cases—25% dead
Resection .....	263 cases—41% dead	257 cases—28% dead

Kausch<sup>4</sup> states, from various statistics, a resection mortality varying between 15 and 53.3 per cent.; on an average about 30 per cent. The incomparably lowest operation mortality ever noted in regard to any very great material, is that of the Mayo Clinic, with 13.7 per cent. of 736 resections (October, 1897–1918), *vide* Ch. Mayo.<sup>9</sup> W. Mayo<sup>7</sup> reports that, even in the case of a large material with terminolateral-antecolic gastro-enterostomy, it was found possible to reduce the operation-mortality to no more than 6 per cent.

Although, consequently, the brilliant operative technic of an individual operator may render possible an exceptionally low mortality, it is clear, on the other hand, that, on the whole, the mortality in the case of various operators must very greatly depend on how widely the indications for resection are applied, and also how radically the one operator proceeds as compared with another.

Kausch<sup>4</sup> also points out, *inter alia*, that the immediate operation results have steadily improved during the course of years, and this in spite of the ever-expanding operative technics.

How do matters stand in this respect concerning our material?

The earlier portion of this material has, on a previous occasion, been investigated with respect to operation mortality. J. Waldenström,<sup>11</sup> for the period up to 1910, inclusive, was able to show, out of 123 cases, an operation mortality of 22 per cent. *In contrast with this relatively low figure, we have a mortality of 31 per cent. for the period 1911–1926.*

5-year periods	Total operated cases	Number of resections	Per cent. resections of all operated cases	Operative mortality in resection cases
1887–91	18	7	38.8	57.1 p.c.
1892–96	58	14	24.1	35.7 p.c.
1897–1901	116	23	20	8.7 p.c.
1902–06	136	35	25.7	20 p.c.
1907–11	187	55	29.4	25.4 p.c.
1912–16	209	63	30.1	27 p.c.
1917–21	201	72	35.8	23.6 p.c.
1922–26	225	92	40.9	38 p.c.
	1150	361	31.4	28 p.c.

To be able to obtain a view of the varying mortality percentage at different periods of the forty years, I have made, in the preceding table, a division of the material into five-year periods:

The table shows how the number of resections during the five-year periods have steadily increased from 7 to 92. It shows how the operation mortality first sinks from 57.1 to 8.7 per cent. during the first three periods, after which it almost steadily increases to 38 per cent. Instead of a decrease, we discover,

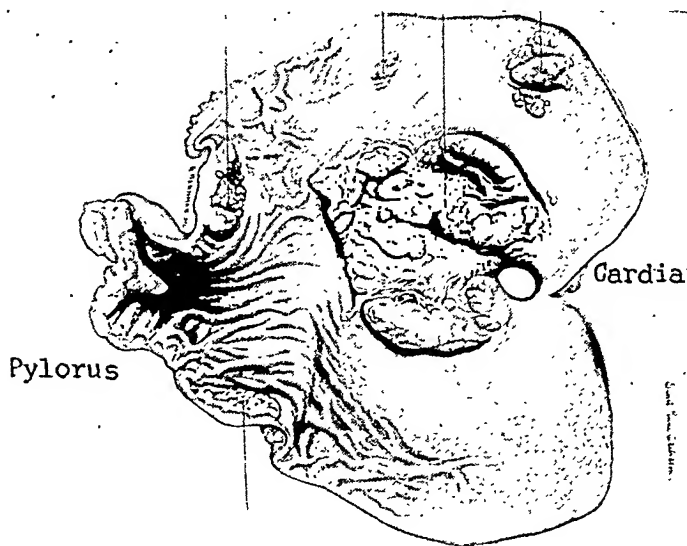


FIG. 2.—Inside of the specimen Fig. 1.

then, an *increase in the operative mortality.*

This increase in the first place is due to *widened indications.*

Such are, undoubtedly, good things in so far that they allow to advanced cases, too, an opportunity of obtaining a longer and even more supportable respite period; nay, in some instances, perhaps even of definite health.

Troell<sup>9</sup> has shown that "as contrasted with a post-operative average life of 15–20 months in cases of resection for cancer ventriculi who die later on from a relapse, we have . . . , at the Seraphimer Hospital an average life of no more than 7.5 months after gastro-enterostomy for the same disease." Waldenström's investigations<sup>11</sup> showed that as all resected cases which had lived any length of time, once more showed symptoms only a short time (2–7 months) before death.

That, by means of resection, even advanced cases can, in some few instances, be restored to perfect health, is shown by one of our cases (No. 14, sub iv d), who, after a subtotal gastrectomy for a very severe adenocarcinoma, affecting the entire curvatura minor up to a few centimetres from cardia and down to the pylorus, enjoyed good health for more than eight years, and, at present, both röntgenologically and clinically, is free from any sign of relapse. This case, judging from the skiagram, was inoperable, and the operation could be brought to a conclusion only with considerable difficulty.

The following history\* shows that even very advanced cases can, with advantage, be submitted to resection, provided that there is an absence of distant metastasis:

I. 1105/1926. Male, forty-seven years of age. Symptoms since 1923. No palpable tumor. The skiagram showed a tumor infiltration within fornix which pushed cardia and corpus forward; the infiltration extended into the major side of corpus, too. Operation, October 8 (Troell): *Total Gastrectomy*.—A very widely extended ulcerated cancer larger than a fist and going from curvatura minor and extending from cardia to angulus.

\* The case is described at length by Troell, Losell and Karlmark.<sup>10</sup>

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In addition, there were found a large number of smaller cancer tumors here and there in the stomach, some of them in fornix ventriculi and others in canalis. Between the upper limit of the large tumor and the proximal resection scission through the œsophagus there was a cm. healthy wall. Anatomico-pathological diagnosis (Professor Henschen): Greatly infiltrated adenocarcinoma passing into cancer simplex; farthest proximally all the layers of the normal œsophagus wall were found remaining. Uncomplicated course. March, 1927: Well and able to work.

Figures 1 and 2 show the operation preparation.

On metabolism experiments made after the entire stomach had been removed quite normal conditions were found concerning the possibility of utilizing albumin, fats, and carbohydrates.

That, during the course of the period under discussion, the indications for resection have been steadily increasing can be shown in two different ways.

If we place the number of resections carried out during the various time-periods in relation to the total number of cancer cases treated and verified by operation, we obtain a certain measure of the boldness and activity, or of the caution and reserve which distinguish the surgical treatment in this sphere during the different periods.

These conditions are shown by the table on page 323, or in a graphic representation by the diagram, Fig. 3.

Thus, we are able to show a striking and, I may venture to say, scarcely accidental, agreement between the resection percentage and that of the mortality. As a matter of fact, the phenomenon seems self-evident: the wider the field of indications for resection, the greater the mortality.

A second way of proving the extended indications is the actual investigation of the degree of technical difficulty of the resection material, with the assistance of the operative records.

In this way we find that there has taken place a displacement toward technically more difficult material, and that in an eminent degree.

During the first ten-year period, 80 per cent. of the tumors were localized to the pylorus or its immediate neighborhood, and, according to present standards, were, technically, extremely simple. Simultaneously, there occurred two cases where a large part of the stomach was involved, and where colon resection was necessary. These cases terminated in death. During the last period (1922-1926) only 15.2 per cent. were pylorus tumors. The following table shows these conditions, together with the really lower mortality for the pylorus cancer cases:

	1887-96	1897-1906	1907-11	1912-16	1917-21	1922-26
Pylorus cancer.....	80 p.c.	71 p.c.	59 p.c.	42 p.c.	21.7 p.c.	15.2 p.c.
Their mortality.....	37.5 p.c.	5.3 p.c.	20.7 p.c.	19.2 p.c.	20 p.c.	21.5 p.c.
Total mortality.....	43 p.c.	15.5 p.c.	25.4 p.c.	27 p.c.	23.9 p.c.	38 p.c.

While the number of, from an operation-technical point of view, simple cases, has steadily fallen, the percentage of those which are technically more difficult has increased—among these, too, the number of cases with simultaneous colon resection which, according to all experience, are the most difficult to bring to a conclusion with conservation of life.

Of 19 cases with simultaneous colon resection, 15 have occurred during the last fifteen years. Of these, 8 died in connection with the operation, corresponding to 42 per cent. (as against 28 per cent. for the entire material), a low figure in comparison with corresponding ones in the literature.

Mau<sup>6</sup> communicates a summary of 18 cases from the surgical University clinic at Kiel, up to, and inclusive of the year 1920, besides the 83 cases with sufficiently accurate data hitherto published in the literature. Of all these 101 cases, there died in connection with the operation 55 (about 55 per cent.).

The gain signified by the prospect of cure to advanced cases afforded by the extended indications for resection, must not, however, be obtained at the cost of an altogether too high an operation mortality. This is already high enough to lessen the reputation of surgical treatment as a remedy for cancer of the stomach, as many a patient, perhaps even in an early stage of the disease, may thereby become afraid to submit to operation, preferring to allow the cancer to run its course some months to running the risk of a very dangerous operation, wherein life may be risked. The aim should be, that increased technical skill, based

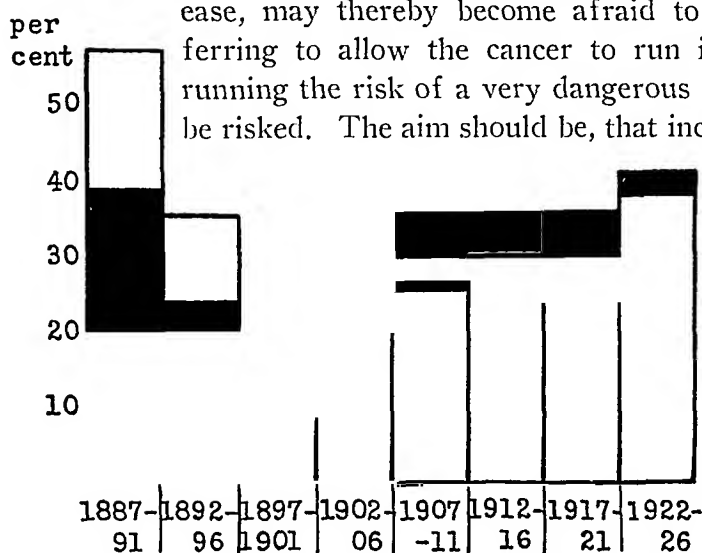


FIG. 3.—The tops of the white columns show the operation-mortality in percentages; that of the black, the percentages of resection.

on massed experience, will be able to allow of extended indications without any increase in the mortality. That this aim is not out of reach is shown by the figures from the Mayo Clinic, cited above.

There also exists a special factor to be emphasized here as an evidence that the cancer operation material,

during the course of years, has grown more difficult from a technical point of view. In Sweden (as everywhere else) the entire development of "stomach surgery" has taken place during the forty years embraced by this paper. At first the Seraphimer Hospital was almost the only place in the country where resection was ever performed. By degrees, this condition of things has been so far altered that such operations are carried out on an increasing, and, very often, fairly great scale in hospitals all over the country. What, now, were the cases which at first were submitted to operation? Well, cases with retention vomiting, almost all of them with palpable tumor in the region of pylorus. The others, as a rule, were not diagnosed before they had become inoperable. Nowadays, the number of resections at the Seraphimer Hospital has steadily increased, in spite of this being the case, too, at other hospitals all over the country. This signifies that a number of technically more difficult cases have come to operation, and that pylorus cancers, during the last few years have constituted the minority. For, presupposing that the frequency of gastric cancer in Sweden has been approximately equally numerous during all these years (Nyström's figures for 1905 and 1911 speak strongly in favor of this hypothesis), then the unheard-of increased operation frequency must, of itself, point to many more difficult cases now being included, and thus contributing to increasing operation mortality at the hospital. The progress made in Röntgen examinations has played a great part in this matter besides.

The increase in the operative mortality is, in the second place, in a measure due to a peculiar and great displacement of the material from feminine to masculine excess.

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Most agree that women have a greater power of resistance to operations than men. In the material from the Seraphimer Hospital, the men have displayed a mortality which is more than 50 per cent. greater than that of the women. Of 210 men operated there died 69 (32.9 per cent.), while of 151 women operated, 32 died (21.2 per cent.).

In the period 1887-1896, the women constituted 71.4 per cent. In the period 1922-1926 only 29.3 per cent. In graphic representation, this peculiar displacement is illustrated as shown by Fig. 4.

*Causes of Death.*—In this paper, there has been reported, as cause of death, intra-abdominal complication in every case where it has been possible to prove its existence. This has been done even if a simultaneous pulmonary affection or any other contributory cause of death has existed. Seventy-one patients (19.6 per cent. of all the cases operated) have died of abdominal complications. Eighteen (5 per cent.) have died of pulmonary complications.

In addition to these, there have been proved, in 12 cases, causes of death which have been of a more accidental character; operative shock in three instances; chloroform intoxication in two cases; heart failure in five cases (one vitium organic. cordis; the others myocarditis); uræmia e nephrocirrhusi ren. solitar., and status epilepticus e tumor cerebri metastat., one case of each. In these twelve cases there was an absence of clinical signs of lung or abdominal complications, and all, with exception of two, have been dissected.

*Pulmonary complications* are not of the same value for judging the advantages and disadvantages of the different methods of operation, as abdominal complications are. They will be dismissed, therefore, in a very few words.

In 1 case was present pulmonary embolism twelve days after operation, a fairly troublesome Billroth II, with liver and pancreas resection. In 2 cases the cause of death was pleural empyema; in 3 cases pulmonary gangrene, and, finally, in 12 cases, post-operative pneumonias. In all the latter (with the exception of a woman, forty-two years of age, with simultaneous goitre and pulmonary emphysema), the patients were sixty years of age and more; 4 of them were even as old as seventy or seventy-five.

*Abdominal complications* will now be the object of our investigation. As will be seen by the accompanying table, their frequency has been fairly equal during the last two decades.

10 year periods	Number of resections	Total dead in complications	
		Pulmonary	Abdominal
1887-96	21	2 (9.5 p.c.)	5 (23.8 p.c.)
1897-1906	58	0	9 (15.5 p.c.)
1907-16	118	4 (3.4 p.c.)	23 (19.5 p.c.)
1917-26	164	12 (7.3 p.c.)	34 (20.7 p.c.)
	<u>361</u>	<u>18 (5 p.c.)</u>	<u>71 (19.6 p.c.)</u>

The following table shows the frequency of different complications according to the different methods of operation:

Resection	Number of cases	Primary deaths	Complications		
			Intra-abdominal	Pulmonary	Other
Segmentary.....	2	2	2	..	..
Transverse.....	9	2	2	..	..
Billroth I.....	32	12 (37.5 p.c.)	6 (18.7 p.c.)	3 (9.4 p.c.)	3
Kocher.....	4	1	1	..	..
Billroth II.....	210	44 (21 p.c.)	30 (14.3 p.c.)	8 (3.8 p.c.)	6
Polya*.....	101	38 (37.6 p.c.)	28 (27.7 p.c.)	7 (7 p.c.)	3
Total gastrect.....	3	2	2	..	..
	361	101 (28 p.c.)	71 (19.7 p.c.)	18 (5 p.c.)	12

\* In Sweden, this was, from the very beginning, advanced independently by Rissler.

The term "abdominal complication" comprises many different kinds of complications. The following table shows, as briefly as possible, the various abdominal complications that have occurred, and their relative frequency:

Intra-abdominal bleeding .....	1
Necrosis of pancreas .....	2
Diffuse peritonitis .....	42
Circumscribed peritonitis .....	16
Ileus .....	7
Fistula—Marasmus .....	3
	—
	71

In the 58 cases of peritonitis, suture insufficiency was stated in 23 of them; its absence in 24 cases. Seven cases were not dissected.

The only instance of lethal bleeding that has occurred was in the case of a patient, thirty-seven years of age, a man very much run down and cachectic (1889) with a pylorus cancer, adherent to the pancreas. On performing the pancreas resection thus rendered necessary, there arose a very severe bleeding which it was possible to arrest, however, by means of ligatures. The patient died three days after the operation. The dissection exhibited one-half litre of blood in the abdominal cavity, and a completely bloodless patient.

In 2 cases, the cause of death was necrosis of the pancreas. In the one instance, there existed simultaneously a phthisis pulmonum which was diagnosed before the operation, and, in the other case, a bronchopneumonia, these being contributory causes of death.

### III. METHODS OF OPERATION AND ABDOMINAL COMPLICATIONS

Peritonitis, ileus, and post-operative fistula formation are really the abdominal complications that can be of some importance when judging of the relative values of the different methods of operation.

Of 32 cases, operated according to Billroth I, 12 (37.5 per cent.) died, 6 of whom in intra-abdominal complications: bleeding and necrosis of the pancreas (1 case of each); diffuse peritonitis (3 cases, two of them originating from a suture insufficiency in the angle between the stomach suture and the gastrodudenostomy), and, finally, 1 case of paralytic ventricle-ileus the third week after the operation.

In the last-mentioned case, nearly the whole curvatura minor and more



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than a half of the major had been removed. There was attempted secondarily, without success, gastrostomy and anterior gastro-enterostomy with entero-anastomosis.

Of 210 cases operated according to Billroth II, there died 44 (21 per cent.), 30 of whom (14.3 per cent.) in abdominal complications: necrosis of the pancreas (1 case); peritonitis (27 cases); strangulation ileus and fistula of the duodenum with marasmus (1 case of each).

Of the cases of peritonitis, 18 were diffuse and 9 circumscribed. In 11 cases there was proved on dissection suture insufficiency; in 11 cases, too, there was found (as far as could be judged on dissection) its absence, while, finally, in 3 cases was no dissection carried out. In 2 cases, the peritonitis was caused by circumscribed gangrene of intestines. In one of these cases, relaparotomy had had to be performed in consequence of a colon stricture within a too short, antecolic-laid jejunal loop. In other case, there existed infarction of a portion of transverse colon. During operation "several fairly thick branches of art. colica media" had had to be ligated in consequence of extensive adhesions of tumor to mesocolon and colon transversum. It is said that, during operation, there were observed no signs of nutrition disturbances of colon.

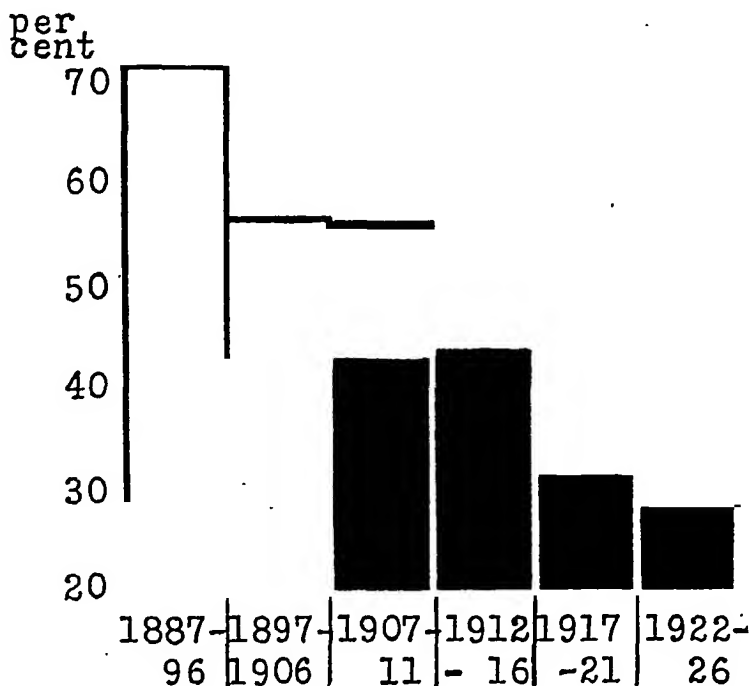


FIG. 4.—The tops of white columns show the number of women in percentage of the whole number of resection material; the black columns are the men, in percentage.

### The suture insufficiency

was in 9 of the 11 cases localized to the stomach suture or gastro-enterostomy; in 2 cases to the duodenal stump. In one of the latter cases, a little tampon had been laid against the duodenal stump, a considerable amount of duodenal contents having issued. A couple of days after the removal of the tampon, there began a flow of bile through the laparotomy wound. The patient died three weeks after the operation, with duodenal fistula, circumscribed peritonitis and phlegmon of the abdominal wall.

In the above-mentioned case of duodenal fistula with marasmus, the duodenal suture had had to be laid in infiltrated tissue. Death one month after operation.

Of 101 cases, operated according to Polya, there died 38 (37.6 per cent.), 28 of whom (27.7 per cent.) in abdominal complications: peritonitis (21 cases); ileus (5 cases), and fistula ventriculi + marasmus (2 cases).

The peritonitis was, in 17 cases, diffuse, and in 4 circumscribed. Suture insufficiency was found in 7 cases; its absence in 12 cases, and, finally, no dissection was made in 2 cases. It was, in 3 cases, to be sought for at the duodenal stump; in 4 at the place of the gastro-enterostomy.

In additional 2 cases there occurred suture insufficiency, but without any actual peritonitis. They had been drained in consequence of the issue of stomachic contents and parenchymatous bleeding, respectively. Two to three days after operation there appeared ventricle fistula and the patients went to exitus in somewhat more than one month after continued inanition.

The 5 cases of ileus were all of a purely mechanical nature; dilatatio permagna duodeni in consequence of the overfilling of the afferent gastro-enterostomy loop (2 cases); incarceration of the small intestine in the mesocolon aperture (2 cases); a sharp turn in the middle of transverse colon due to adhesion to the operation wound (1 case), the symptoms arising thirteen days after operation. Relaparotomy; cæcal fistula; in vain.

On the whole, then, it is the same complications that arose after the Polya operation and after Billroth II, although, after Polya, the number of complications was considerably greater. With a number of operations according to Polya, less than half the number of those performed according to Billroth II, there have occurred only 2 abdominal complications less than with Billroth II; only 6 cases of peritonitis less (21 as against 27), of which, practically speaking, there were just as many diffuse (17 as against 18); more than half as many cases of suture insufficiency (7 as compared with 11, or, if, in addition, the post-operative fistulas with marasmus be counted to, 9 as against 11), and, finally, a considerably greater number of post-operative ileus (5 to 1).

It should be remarked, however, that, taken as a whole, Billroth II has probably been employed on a technically, somewhat easier material than Polya (earlier in the statistics).

#### IV. LATE RESULTS

Respect has been paid only to the cases where the operation took place more than five years back; those, consequently, up to and inclusive of the year 1921. Only 3 of the surviving patients have not been found. The following table forms a report of the fate of the patients who were operated on more than five years ago:

Number operated on during the years 1887-1921 .....	269
Operative mortality .....	66 (24.5%)
Discharged alive .....	203
Of these, have not been found .....	3
Patients with complete post-operative data .....	200
Of these, dead within five years, most after relapse .....	161 (80.5%)
More than five years after operation died of relapse .....	12
More than five years after operation died of another disease .....	9
Living, healthy (six and a half to twenty years after operation) ..	17
Living, healthy? .....	1

a. *Patients Dead of Relapse in Five Years After Operation.*—Of 161 deaths in five years, probably all, with the exception of 2, have been caused by relapse (1 pneumonia after four years; 1 suicide after three years).

In the first year: died, 61; in the second, 61; in the third, 26; in the fourth, 9; in the fifth, 4.

Thus, 53 patients (26.5 per cent.) have lived more than three years after operation; 39 (19.5 per cent.) more than five years.

## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

For the sake of comparison, there are given here Nyström's<sup>8</sup> corresponding figures for the whole of Sweden. Of 225 cases radically operated during 1911, there died in connection with the operation 46. Respecting 7 more, no information could be obtained respecting the further course. Of 172 cases that could be investigated later, 38 (22.1 per cent.) lived more than five years.

Although, therefore, most of the patients that died in relapse, did so within three years, there remain, as is shown by the above table, sufficiently many deaths in relapse after three, nay even after five years, to clearly show that, in the individual case, there is always a fear, even after the lapse of a considerable number of years, of the hope of a radical cure being spoiled.

*b. Patients Dead in Relapse Later Than Five Years After Operation.*—Twelve died; these cases are tabulated below:

No.	Operation	Tumor loc.	Metastases	Microscopic	Died after operation
1	Billroth II	Pylorus	o	Malign papilloma	14 yrs. 6 mos.
2	Billroth II	Pylorus	o	Adenocarcinoma	6 yrs. 1 mo.
3	Billroth II	Pylorus	o	Cancer	7 yrs. 1 mo.
4	Billroth II	Pylorus	o	Adenocarcinoma	5 yrs. 7 mos.
5	Billroth II	Pylorus	o	Cancer	17 yrs. 0 mos.
6	Billroth II	Pylorus	o	Ulcus carcinomat.	5 yrs. 4 mos.
7	Billroth II	Pylorus	o	Adenocarcinoma	10 yrs. 2 mos.
8	Billroth II	Pylorus	o	Cancer gelatinos.	8 yrs. 8 mos.
9	Billroth II	Pylorus	Ca. lymphogl.	Adenocarcinoma	5 yrs. 4 mos.
10	Billroth II	Pylorus	o		7 yrs. 9 mos.
11	Polya+Col. res.	Curv. major	o	Cancer scirrhus.	6 yrs. 6 mos.
12	Billroth II	Curv. minor, up to pylorus	o	Cancer	7 yrs. 5 mos.

Many different histological types of cancer are thus represented. A distinguishing feature of these late relapses is, that in most cases, the cancer has been localized to the pylorus and its most immediate neighborhood; this, with really but one exception. In this, the cancer was localized in *curvatura major*, at the beginning of the transverse part of the stomach and going on to mesocolon, with a drawing up of the colon. In addition, only in one case has cancer been proved to exist in regional lymphatic glands. In all the other cases, any possible glands have been soft and, judging from palpation, it has been possible to remove them to a satisfactory degree, and, in the cases that have been examined microscopically, have been cancer-free.

In all these cases, the patients have, subjectively, been in good health for several years after the operation, and it has only been from some months to half a year before death that they have once more felt their former ailments, with emaciation, vomiting, and, in certain instances, ascites, jaundice, etc. There has, thus, been a palliative result, which must be regarded as extraordinary.

Case No. 1 in the table is the only one where the relapse has not been fully proved (by dissection, relaparotomy, hospital care, etc.). The clinical symptoms, which developed during the last year of the woman's life, were described by her surviving son; the communication could not be interpreted any other way, however, than that the cause of

this patient's death was a relapse of the cancer. J. Waldenström<sup>11</sup> makes public a case of relapse thirteen years after operation: Male, fifty-eight years of age. Operation 1897 (Berg): Adenocarcinoma, commencing at curvatura minor. Patient died 1910 of influenza. Dissection displayed an extensive relapse in the stomach.

c. *Patients Dead of Another Disease Later Than Five Years After Operation.*—Nine died.

No.	Operation	Tumor loc.	Metastases	Microscopic	Died after op.	Cause
1	Billroth I	Pylorus	o		14 yrs. 6 mos.	Suicide.
2	Billroth II	Pylorus	o	Cancer	9 yrs.	Ca. coli.
3	Billroth II	Pylorus	o		15 yrs.	Ca. recti.
4	Billroth II	Pylorus	o	Adenocarcinoma	7 yrs. 4 mos.	Tub. pulmon.
5	Billroth II	Pylorus	Cancer lymphogl.	Cancer	5 yrs. 8 mos.	Senility.
6	Billroth II	Curv. minor	Cancer lymphogl.	Cancer	9 yrs. 6 mos.	Senility.
7	Billroth II	Curv. minor	o	Cancer simpl.	9 yrs. 10 mos.	Anemia.
8	Billroth II	Curv. minor	o	Cancer	13 yrs. 6 mos.	Senility.
9	Billroth II	Curv. minor	o	Adenocarcinoma	7 yrs. 11 mos.	Appendicitis.

In all these cases the cause of death is stated by physicians: In 6 of them during the patient's stay in a hospital, in spite of which *some of the cases seem to me to be suspected to have been cancer relapses, too.*

Below are given some brief casebook extracts respecting the patients. The numbers refer to the above table:

1. II. 54/1892. Male, thirty-four years of age. Symptoms for one and a half years. Palpable, movable tumor. Retention. Operation 19/2 (Berg): *Billroth I.*—Kidney-like cancer surrounding pylorus. The patient hanged himself 1906. No symptoms of relapse.

2. I. 29/1900. Male, forty years of age. Symptoms for half a year. No palpable tumor. Operation 11/1 (Berg): *Billroth II.*—Pylorus tumor. Histological: polymorphous-celled, in part very cell-rich cancer. Healthy until 1908. Operated in January, 1909, for an adenocarcinoma in the sigmoid flexure, at the Seraphimer Hospital. Died of post-operative peritonitis. *Dissection showed stomach and surrounding lymphatic glands macro- and microscopically free from cancer.* No macroscopic cancer anywhere else either.

3. I. 783/1901. Female, fifty-one years of age. Symptoms two months. Palpable, movable tumor. Operation 19/12 (Berg): *Billroth II.*—Mandarin-orange-sized tumor in posterior wall close to pylorus. Died 8/11, 1916, in rectal cancer.

4. I. 72/1904. Male, fifty years of age. Dyspeptic symptoms for many years. Now, for one-half year vomiting and emaciation. Palpable, movable tumor. Retention. Pulmonary tuberculosis. Operation 31/10 (Berg): *Billroth II.*—Extended pylorus tumor. Adhesions to pancreas. Regional glands enlarged. Histologic: Adenocarcinoma. Patient examined 1910: Advanced, double-sided pulmonary tuberculosis. In other respects healthy. He died of pulmonary tuberculosis at another hospital 11/3, 1912. No relapse.

5. I. 613/1911. Male, sixty-six years of age. Symptoms for two years back. Operation 9/8 (Nyström): *Billroth II.*—Pylorus tumor. Histological diagnosis: Cancer in pylorus and in glands from omentum. Patient died 11/4, 1917, at another hospital in senile gangrene. No sign of relapse.

6. I. 778/1911. Male, sixty-six years of age. Symptoms for a month back. No palpable tumor. No retention. Operation 23/9 (Lidén): *Billroth II.*—5-6 cm. broad tumor on anterior wall, at curvatura minor, proximally to the pylorus. Histological

# FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER



FIG. 5



FIG. 6



FIG. 7

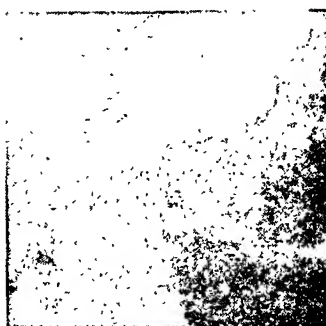


FIG. 8

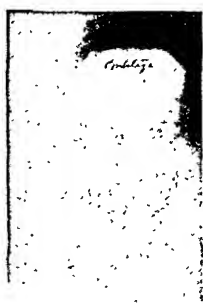


FIG. 9



FIG. 10



FIG. 11



A

FIG. 12

FIG. 5.—Skiagram from Case 8 (Sub.IVC) A. Before operation. B. 13 years after operation. FIGS. 6-12.—Skiagrams from cases 3, 5-10 (Sub. IVd). A. Signed before operation. All others at post-investigation.

diagnosis: Cancer, also in lymphatic glands from omentum minus. Patient died, seventy-six years old, 10/4, 1921, of old age. No sign of relapse.

7. I. 955/1911. Female, sixty-one years of age. Operation 22/II (Berg): *Billroth II*.—Tumor as large as a fist. A few glands regionally. Histological diagnosis: Carcinoma simplex. Patient died 2/9, 1921, at age of seventy-one of anæmia. Is said to have exhibited no signs of cancer relapse, but seems to me suspected.

8. I. 1168/1912. Female, sixty-seven years of age. Symptoms for three months back. Palpable tumor. X-ray (Fig. 5A): In canalis, a defect as large as a mandarin-orange, with uneven, ragged edges. After five hours great retention. Operation 12/12 (Berg): *Billroth II*.—Tumor, as large as an orange in pars pylorica, extending somewhat up into curvatura minor. Regional, soft glands. Histological diagnosis: Cancer. Patient died of old age at eighty-one, at another hospital, on 5/6, 1926. X-ray 13/II, 1925, (Fig. 5B): The lower part of the stomach remainder shows an uneven contour, but not more than is usual with resection stomachs in general. No certain cancer infiltration. After four hours there were some slight rests in the stomach.

9. I. 220/1915. Male, fifty-three years of age. Symptoms for three months previously. No palpable tumor. X-ray: Tumor defect in canalis, immediately below angulus of the size of a walnut. Inconsiderable retention after four hours. Operation 19/3 (Berg): *Billroth II*.—Large tumor, starting from the posterior wall of the stomach, at curvatura minor, with large crater. Histological diagnosis: Adenocarcinoma. Patient died at another hospital 18/2, 1923, of gangrenous appendicitis with peritonitis. No relapse.

d. *Patients Still Alive, More Than Five Years After Operation*.—Eighteen patients are living, six to twenty years after operation.

No.	Operation	Tumor loc.	Metastases	Microscopic	Lived after oper.
1	Billroth II	Posterior wall	Glands (nature ?)	Cancer	20 years
2	Billroth II	Pylorus	Glands (nature ?)		19 years
3	Polya	Pylorus	Glands (nature ?)		18 years
4	B. II + Col. res.	Major curvature	Mesocolic adhesion		18 years
5	Billroth II	Pylorus	o	Adenocarcinoma	17 years
6	Billroth II	Pylorus	Glands (nature ?)	Cancer	16 years
7	Billroth II	Minor curvature	o	Adenocarcinoma	15 years
8	Billroth II	Pylorus	o	Cancer	15 years
9	Kocher	Posterior wall	o	Medullary carc.	14 years
10	Billroth II	Entire canalis	Glands (nature ?)	Adenocarcinoma	13 years
11	Billroth II	Min. curv. at pyl.	Glands (nature ?)		10 years
12	Billroth II	Pylorus	Glands (nature ?)		10 years
13	Polya	Entire min. curv.	o	Adenocarcinoma	9 years
14	Polya	Entire min. curv.	Glands (nature ?)	Adenocarcinoma	8 years
15	Polya	Min. curv. at pyl.	Glands (nature ?)	Cancer	8 years
16	Billroth II	Entire canalis	o		7 years
17	Polya	Pylorus	Glands (nature ?)	Carcinomat. ulcer	7 years
18	Billroth II	Entire canalis	Liver adhesion	Adenocarcinoma	6 years

*In 17 Cases the Patient Has Been Found to be Quite Well Seven to Twenty Years After Operation*.—In one case (No. 18) the question must, for the present, remain undecided (see below).

In all the cases except 4 (Nos. 1, 2, 4, and 11), the clinical post-investigation has been completed by means of X-ray examinations of the stomach.†

In the 12 cases where the diagnosis "cancer" was verified by anatomical-pathological

† I must express my warmest thanks to Professor Forssell and his assistants for the extraordinarily great help they have been to me in the Röntgen post-examinations of the operated cases of cancer.

## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

examination, there are several different kinds of cancer represented, but scirrhus carcinoma.

Among those cases free from relapse, and now living, 10 are men and 7 women. Two of them at the time of operation were sixty-five years old, the others between thirty-six and fifty-six.

Below there are given some brief casebook extracts for the 17 patients who survive and are healthy; the numbers refer to the preceding table:

1. I. 300/1906. Female, thirty-nine years of age. Symptoms for two months previously. Palpable tumor. Operation 23/4 (Landström): *Billroth II*.—Cancer as large as an open hand, on the posterior wall of the stomach, with crater-shaped bottom. Regional lymphatic glands in the curvatures. Adhesions to transverse mesocolon, a part of which had to be excised. Patient lives, quite well, November, 1926.

2. II. 681/1907. Male, forty-seven years of age. Symptoms for eight months previously. Palpable, movable tumor. Considerable retention. Operation 26/9 (Akerman): *Billroth II*.—Tumor as large as a plum in the major side of pylorus. Glands as large as beans in the curvatures. Histological diagnosis: Cancer. Patient lives, quite well, December, 1926.

3. II. 483/1908. Female, fifty-three years of age. Taken ill nine months previously with diarrhoea. Palpable tumor. Operation 29/7 (Key): *Rissler (Polya)*.—Movable cancer, as large as a hen's egg, in pylorus with knots in serosa. Small, *hard glands* in the minor curvature, far up toward cardia, *partly left*. Patient living, quite well, November, 1926. X-ray examination 9/11: Of the stomach there remain fornix and upper part of corpus. The stomach evacuates itself best when the patient is lying on her back, but also to some extent in a standing position. No visible form defect, pointing to tumor (Fig. 6).

4. I. 592/1908. Male, forty-five years of age. Symptoms for five months previously. Palpable tumor. Operation 14/8 (Berg): *Billroth II + Colic Resection*.—Large tumor at major curvature and going on to mesocolon and colon. No metastases. The patient is living, quite well, November, 1926. A hardness of the bowels compels him to constantly make use of laxative.

5. I. 14/1909. Male, thirty-six years of age. For five years previously gastric ulcer-like symptoms. About one year previously, grew worse. No palpable tumor. Considerable retention. Free hydrochloric acid. Total acidity 90. Operation 9/1 (Berg): *Billroth II*.—Pylorus tumor almost the size of a hen's egg. Regional lymphatic glands. Histological diagnosis: Adenocarcinoma; no metastases in glands. Patient is alive, quite well, October, 1926. X-ray examination 11/10: The remaining part of stomach presents soft and even contours. Peristaltic action ordinary. The stomach empties itself through gastro-enterostomy, which seemed to be situated within canalis; action very bad in recumbent position, but somewhat better in standing one. Still, there exists a moderate retention after four hours. No sign of tumor infiltration (Fig. 7).

6. I. 606/1910. Male, fifty-six years of age. Symptoms for eleven months previously. Palpable tumor. Little retention. Free hydrochloric acid. Total acidity 55. Operation 17/8 (Aleman): *Billroth II*.—Tumor as large as a plum, in minor side of pylorus, with ulcer crater. A few small lymphatic glands in omentum minus. Histological diagnosis: Cancer. Patient is living, quite well, October, 1926. Capacity of stomach 1000 c.cm. No retention. No hydrochloric acid. X-ray examination 3/10: Of the stomach there remain fornix and corpus. The stomach everywhere represents soft and even contours. Peristaltic action ordinary. The stomach empties itself rapidly in both standing and prone position. No sign of tumor (Fig. 8).

7. I. 23/1911. Male, fifty-three years of age. Symptoms for three months previously. No palpable tumor. Operation 7/1 (Berg): *Billroth II*.—Tumor as large as a fist, starting with rounded stem of 3 cm. diameter, from minor curvature, freely

ingrowing with a fungus top-like, expanded part, 5 cm. diameter, and 5 cm. in height, in the stomach. Histological diagnosis: Adenocarcinoma. Patient is alive, quite well, October, 1926. X-ray examination 3/10. Of the stomach there remain fornix and an



FIG. 13

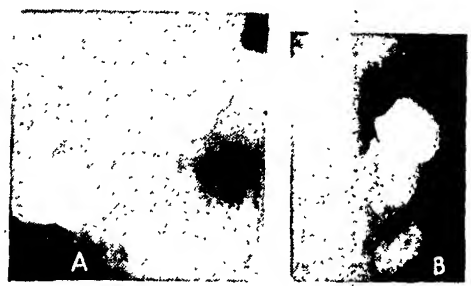


FIG. 14

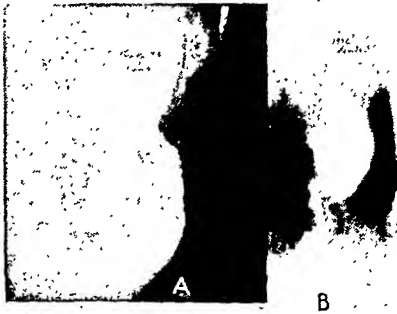


FIG. 15

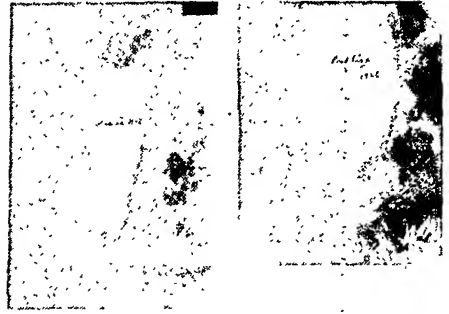


FIG. 16

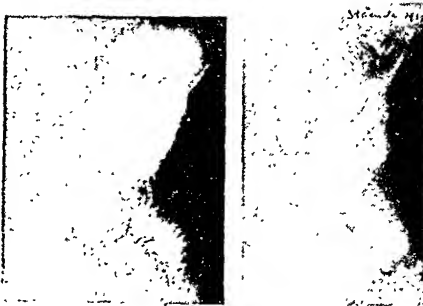


FIG. 17



FIG. 18

FIGS. 13-18.—Skiagraphs from cases 12-17 (Sub. IVd). A. Signed before operation. All others at post investigation.

unimportant part of corpus. The stomach presents soft and even contours; and empties itself rapidly, both in standing and prostrate position. Peristaltic action ordinary. No sign of tumor (Fig. 9).

8. I. 249/1911. Male, fifty-four years of age. Mother died of mammary cancer.



## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

Symptoms for seven months previously. No palpable tumor. Retention. Operation 27/3 (Lidén): *Billroth II.*—Cancer in pylorus as large as a hen's egg. Small glands in the curvatures. Histological diagnosis: Cancer. The patient is living, in good health, October, 1926. Capacity of stomach 1400 c.cm. No retention. No hydrochloric acid. X-ray examination 3/10: Of the stomach there remain fornix and corpus. The stomach evacuates itself rapidly in both standing and prostrate position. It presents soft and even contours. Peristaltic action ordinary. No sign of tumor (Fig. 10).

9. I. 341/1912. Female, fifty-five years of age. Mother died of cancer. Symptoms for four months previously. Tumor not palpable. No retention. Operation 13/4 (Waldenström): *Kocher.*—On the posterior wall of stomach, 7 cm. from pylorus a little infiltration, with a crater-shaped ulceration, 1½ cm. in diameter. Some small lymphatic glands in minor curvature. Small resection. Lower resection scission 2 cm. cardially with respect to pylorus. Histological diagnosis: Medullary carcinoma, June 6, 1912: In consequence of stenosis there was arranged an *anterior gastro-enterostomy* and *entero-anastomosis*. The patient is living, perfectly well, October, 1926. No retention. No hydrochloric acid. X-ray examination. Of the stomach there remain fornix, corpus, sinus and the proximal part of canalis. The stomach empties itself relatively slowly. After four hours inconsiderable retention. The stomach presents even and soft contours. Peristaltic action ordinary. No sign of tumor (Fig. 11).

10. I. 422/1913. Male, forty-one years of age. Mother died of gastric cancer. A brother suffers from cancer of rectum. Symptoms for two years previously. Palpable tumor. Retention. Free hydrochloric acid 15. Total acidity 60. X-ray (Fig. 12A). Filling defect in canalis, with ragged edge to right. After four hours, almost complete retention. Operation 24/4 (Troell): *Billroth II.*—Circular tumor, as large as a hand-palm, bound up with pancreas, occupying the whole of pars canalis. In the gastrocolic ligament, several lymphatic glands reaching to transverse colon. The tumor occupies more than one-third of the stomach. Histological diagnosis: Adenocarcinoma. The patient is still alive and quite well, October, 1926. No retention. No hydrochloric acid. X-ray examination: Of the stomach there remain fornix and the upper part of corpus. The stomach empties itself rapidly, especially in standing position. Peristaltic action ordinary. Soft and even contours everywhere. No signs of tumor (Fig. 12B).

11. I. 230/1916. Male, fifty years of age. Mother died of gastric cancer. Symptoms for fifteen months previously. No palpable tumor. Retention. X-ray examination: Tumor, embracing most of the transverse part of stomach. Great retention after four hours. Operation 29/2 (Berg): *Billroth II.*—Cancer, embracing chiefly pylorus and antrum at minor curvature for a space of some cm. Some swollen lymphatic glands along the curvatures. The patient is still alive and quite well, October, 1926.

12. I. 444/1916. Female, forty years of age. Father died of gastric cancer. Symptoms for one year previously. Palpable, movable tumor. Retention. X-ray examination (Fig. 13A): Considerably enlarged stomach, with filling defect within the pylorus region. Great retention after four hours. Operation 21/4 (Flodérus): *Billroth II.*—Movable tumor as large as an apple in pylorus. Enlarged lymphatic glands in gastro-hepatic and gastrocolic oments. The patient is still living, quite healthy, October, 1926. The capacity of stomach 1000 c.cm. X-ray examination (Fig. 13B): Of the stomach there remain fornix and the upper half of corpus. Soft and even contours everywhere. Peristaltic action ordinary. The stomach evacuates itself rapidly, both in standing and a ventral position. No sign of tumor.

13. I. 753/1917. Male, Sixty-five years of age. Symptoms for five months previously, aching in right side of back, at the twelfth rib. No vomiting or dyspeptic trouble. Emaciation. No palpable tumor. Retention. No hydrochloric acid. Weber's test positive several times. X-ray examination (Fig. 14A): Filling defect reaching up to the neighborhood of cardia. Diagnosis: Corpus cancer, extending up along minor curvature to the cardia tract. Operation 10/8 (Troell): *Polya.*—Large tumor extending along minor curvature and the anterior and posterior walls of stomach. It extends

from the neighborhood of cardia 12 cm. downward to 5 cm. from pylorus. A couple of lymphatic glands, as large as a pea, in the gastrocolic oment. In the removed specimen, the tumor goes on the posterior wall quite close to the upper resection margin. Histological diagnosis: Adenocarcinoma. The patient is still living and quite well, October, 1926. No hydrochloric acid. X-ray examination (Fig. 14B): Of the stomach there remain fornix and an unimportant part of corpus. Soft and even contours everywhere. Peristaltic action ordinary. The stomach empties itself rapidly. No sign of tumor.

14. II. 31/1918. Female, forty-four years of age. Symptoms for one year back.

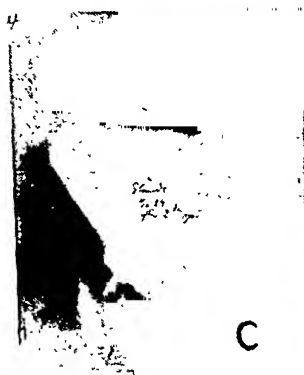
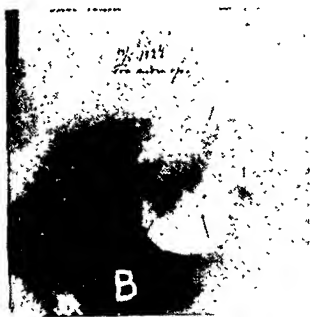


FIG. 19.—Skiagrams from case 18 (Sub. IVd). A. Before 1st resection; B. Before 2nd resection (relapse); C. After 2nd resection; D. At post-investigation.

Palpable, movable tumor. No retention. X-ray examination (Fig. 15A): Large tumor defect creating an indrawing of the stomach contour, starting from minor curvature within the space from just below cardia to pylorus. Average great retention after four hours. Operation 16/1 (Bohmanson): *Polya. Subtotal Gastrectomy*.—The stomach filled with a tumor starting from minor curvature, which leaves only a small part of corpus nearest cardia free. In the gastrocolic oment a row of lymphatic glands, up to the size of a bean. Histological diagnosis: Very cell-rich adenocarcinoma. No cancer in the glands. The patient is still living and quite well, October, 1926. X-ray examination (Fig. 15B): Of the stomach there

remain only fornix and upper part of corpus. The stomach everywhere presents even and soft contours. Peristaltic action ordinary. Rapid evacuation. No sign of tumor.

15. II. 921/1918. Female, sixty-five years of age. Symptoms for one-half year back. Palpable tumor. Great retention. Free hydrochloric acid 42. Total acidity 76. X-ray examination: Antiperistalsis. Filling defect in canal, nearest pylorus. Great retention after four hours. Operation 5/6 (Troell): *Polya*.—Tumor, as large as a hen's egg in the pyloric part, circular, with the greatest extension in minor curvature. In the gastrohepatic oment a couple of enlarged, soft lymphatic glands. Histological diagnosis: Cancer. The patient lives, in good health, October, 1926. X-ray examination (Fig. 16): The stomach presents everywhere soft and even contours. No remains after four hours. No sign of tumor.

16. I. 257/1919. Male, fifty-five years of age. Father died of gastric cancer. Symptoms for one year previously. Palpable, movable tumor. No retention. Operation 14/3 (Ekehorn): *Billroth II*.—Circular cancer, beginning at pylorus and extending about 10 cm. upwards, ulcerated. The patient is alive, quite well, October, 1926. Capacity of stomach 1000 c.cm. No retention. No free hydrochloric acid. X-ray examination (Fig. 17): Of the stomach there remain fornix and corpus. The stomach presents even and soft contours. Normal peristalsis. Rapid evacuation. No sign of tumor.

## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

17. I. 527/1920. Female, forty years of age. Ulcus trouble for nine years back. During last year, worse, with increasing pains in the epigastrium, acid eructations, emaciation. No palpable tumor. Inconsiderable retention. X-ray examination: Here there exists an alteration in the terminal part of canalis close to pylorus, with infiltration in the wall. Whether this is caused by an ulcer or a tumor it is impossible to decide with certainty. After four hours, fairly great retention. Operation 27/5 (Troell): *Polya*.—Infiltration, as large as a thumb, in minor curvature, immediately proximate to pylorus, with ulcer crater. At major curvature some non-malignant lymphatic glands, as large as almonds. Resection 6–7 cm. long. The crater  $2 \times \frac{1}{2}$  cm., goes deep into the muscular wall at minor curvature. Histological diagnosis: Carcinomatous ulcer. The patient is still alive, quite well, February, 1927. No retention. Capacity of stomach 500 c.cm. No free hydrochloric acid. X-ray examination (Fig. 18): Of the stomach there remain fornix and corpus. At the bottom of the resected stomach there lies the gastro-enterostomy opening. The remaining part of stomach presents even, soft contours. No sign of tumor. Rapid emptying.

If we examine the operative records, it is found that certainly it is not all the cases that have been technically simple pylorus tumors, or tumors situated in the neighborhood of pylorus. Cases 1, 4, 10, 13 and 14 present instances of large and extensive gastric cancers, which, with a good result, have been removed by means of resection.

It is, therefore, very striking, that, among the relapse-free cases, there are several which, on operation, have been fairly advanced cases, while, among the late relapses, there is scarcely anything else than pylorus tumors (really, with but one exception). This circumstance is, however, not so very strange as would appear at first sight. If one succeeds, in the operation of a relatively advanced case, in really removing all cancer tissue which microscopically infiltrates the stomach wall round the outside of the tumor, then there is no relapse (provided that there exists no remote metastasis). If one, on the other side, does not succeed, a relapse occurs. But, in advanced cases this, most probably, will occur soon, and, consequently, will not be a late relapse.

In 7 of the 8 cases that were tested in this respect, achylia has been found. In case No. 5 there was discovered free hydrochloric acid 13, and total acidity 40. In this instance, there had been found before operation a hydrochloric acidity 90. (Histological diagnosis: Adenocarcinoma.)

In all the cases examined, there was found a good motility, and clinical retention was absent. The capacity of the stomach has varied between 500 and 1400 c.cm.

In the 13 cases examined by Röntgen, the result of the examination was satisfactory; in several cases there was a rapid emptying of the stomach, usually mostly in a standing position. The wall of the stomach has presented even and soft contours, with ordinary peristalsis. No signs of tumor infiltration.

Most of the patients present normal evacuation. One patient (No. 4) complains, however, of stubborn hardness of the bowels, which compels him to constantly employ some laxative. Another (No. 15) has to eat some apples every day of the same cause. Five patients (Nos. 5, 11, 15–17) state that, on a few occasions, they suffer from a transient diarrhoea; otherwise their evacuations are normal.

Case No. 18 in the preceding table is almost unique, for *the patient, on two occasions, at an interval of three years, has been submitted to resection for gastric cancer*, and at present, three years after the last operation, is clini-

cally and röntgenologically relapse-free. A brief account of this case is given here:

I. 25/1921. Male, forty-six years of age. Father died of cancer, three years before admission; there had been for some months symptoms of gastric ulcer. Three and a half months before admission loss of appetite, eructations, and emaciation, with palpable tumor. X-ray examination (Fig. 19A): Large tumor defect in canalis, beginning 3 cm. distance from angulus, and extending to the vicinity of pylorus, most pronounced on the major side,

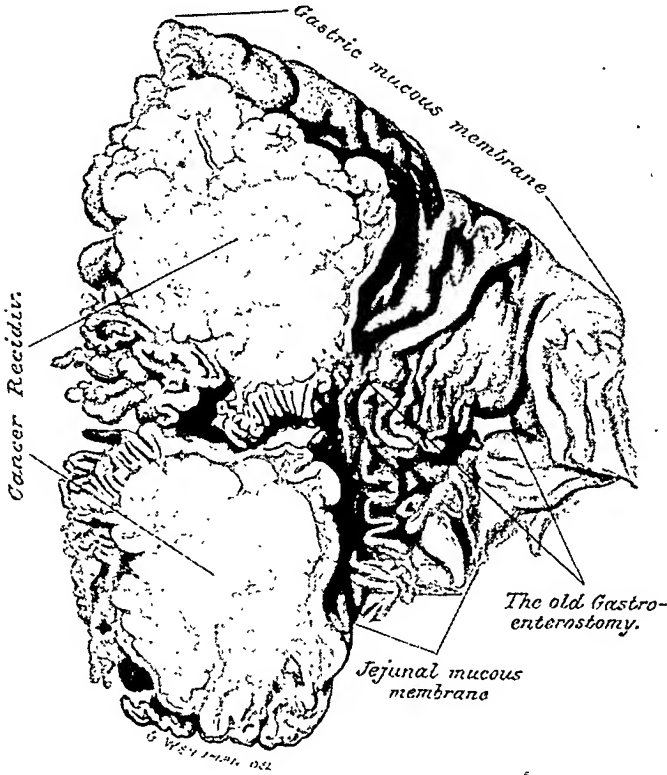


FIG. 20.—Relapse of cancer of the stomach; drawn from a specimen removed by a second operation (atypical resection), three years after the first.

where there is seen a rounded indrawing, with stiff, ragged contours. No retention after four hours. Operation 10/1 (Ekelhorn): *Billroth II*, with anterior gastro-enterostomy and entero-anastomosis.—Circular cancer occupying pars pylorica from and inclusive of the pylorus itself, 10 cm. long in minor curvature, and 15 cm. in major. Adhesions to liver, gall-bladder and the other surrounding parts. The entire transverse part of the stomach was removed. The greater part of the surface of the tumor was ulcerated. The ulceration surrounded by a high wall. Anatomico-pathological diagnosis: Adenocarcinoma. Discharged cured.

The patient afterward remained subjectively well until March, 1924, when he began to be troubled by eructations and vomitings within one-half hour after food, pains in the epigastrium, emaciation and lassitude. Readmitted 19/5, 1924. Retention. Achylia. Capacity of stomach 1800 c.cm. Weber's test in faeces positive. X-ray examination (Fig. 19B): Of the stomach there remain only fornix and corpus. The contrast empties itself at a fairly slow rate through the gastro-enterostomy. At this place there is visible a defect in the contrast, as large as a good-sized mandarin-orange. The contours of the defect are sharp and stiff. Diagnosis: Malignant infiltration. Operation 21/5 (Troell): *Atypical resection* of stomach and jejunum, with antecolic, terminolateral gastro-enterostomy.—From the upper angle of the gastro-enterostomy there extended upward into the wall of the stomach and the gastrocolic oment, a knotty cancer, as large as an apple, with adhesions to pancreas. The gastro-enterostomy was removed entirely. The loops of jejunum were divided below the gastro-enterostomy, and were anastomosed end to end. In the removed specimen (Fig. 20) the gastric wall is seen to be free, with the exception of a place to the right in the minor curvature, where a part of harder consistency, spreads like a sponge over the surrounding parts. Histological diagnosis; Adenocarcinoma. X-ray examination, three weeks after operation (Fig. 19C): Gastro-enterostomy opening fairly narrow or, possibly, somewhat contracted. In prostrate position slight evacuation of stomach; quicker in standing position. After four hours great remains in stomach. Discharged 13/6.

## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

31/3, 1926: Good general condition. No palpable tumor. Weber's test negative. No retention. No free hydrochloric acid. Total acidity 10. X-ray examination 3/4 (Fig. 19D): Of the stomach are seen to remain only fornix and upper part of corpus. The gastro-enterostomy has a width of about 1 cm. Slow evacuation in prone position, quick in a standing one. The stomach exhibits even contours. Ordinary peristalsis. After four hours no retention. No visible form defects that point to a tumor relapse.

April, 1927: The patient is still living, and, subjectively, is quite well.

In this case, consequently, nothing can yet be said as to the future prospects of the patient. Judging by the röntgenologically shown freedom from relapse, two years after the last resection, taken together with the absence of subjective trouble three years after the last operation, they may be supposed to be not very dark, however.

### V. METHODS OF OPERATION AND LATE RESULTS

From the table on page 331 there will be seen that 203 patients survived the operation, out of 269 who had been operated on before 1922. Of these, 3 were not found. The following table shows the various methods of operation employed, and also the time within which the relapse has occurred in the different cases:

Resection	Number	Number of lapses occurring the												No relapse
		1st	2nd	3rd	4th	5th	6th	7th	8th	9th	11th	15th	17th year	
Transverse—Kocher and Billroth I.....	17	4	6	4		1								2
Billroth II and Polya.....	183	61	55	18	9	4	3	2	3	1	1	1	1	24

To the *upper group* there belong technically relatively simple cases where the cancer was situated in, or close to, pylorus, and has been of very little size, and, in addition, 3 cases (transverse resection), where the tumor was localized to canalis. They also belong, with the exception of the 3 cases of transverse resection, to the earliest in the material.

Two cases are relapse-free fourteen years after operation; 14 have died within the space of three years, and another within five years after operation. It is, consequently, remarkable that *not a single patient who was operated on according to Billroth I, or other methods comparable with this, belongs to the cases of late relapse.*

To the *lower group* belong the cases of all degrees of difficulty, among them 8 where, simultaneously, colon resection was necessary.

Twenty-four cases have been relapse-free six to twenty years after operation. One hundred and thirty-four have died of relapse within five years. *In addition, 12 more have died of relapse within a period of from five years and four months to seventeen years after operation.*

The number of surviving cases operated on according to Billroth I and similar methods, is, unfortunately, too little to allow of a percentage comparison with Billroth II and Polya, as regards the frequency of relapse-free cases. But to judge by the many cases of late relapse *Billroth II and Polya have, in our material at least, proved themselves absolutely superior to Billroth I and similar methods, as palliative operations.*

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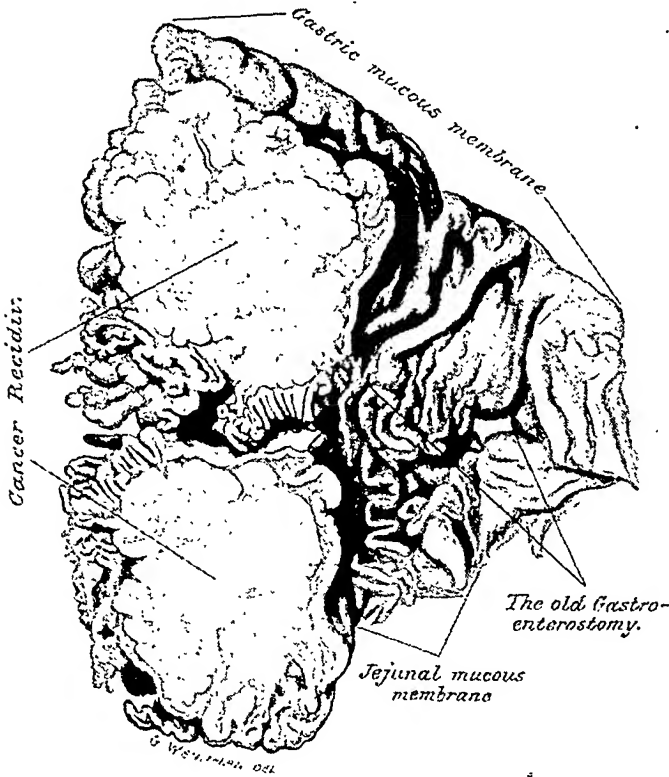


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The number of surviving cases operated on according to Billroth I and similar methods, is, unfortunately, too little to allow of a percentage comparison with Billroth II and Polya, as regards the frequency of relapse-free cases. But to judge by the many cases of late relapse *Billroth II and Polya have, in our material at least, proved themselves absolutely superior to Billroth I and similar methods, as palliative operations.*

This, as a matter of fact, is by no means astonishing, when we consider the tendency cancer of the stomach has to spread in the mucous membrane and submucosa, in fine, microscopical streaks, in many instances far beyond the macroscopic limits of the tumor.<sup>3</sup> It is a matter of course that the operator, in Billroth II and its modification Polya, can more easily determine to remove a very large part of the stomach than is the case in Billroth I, where one is obliged, at any cost, to avoid that tension on the sutures which would expose the immediate results to very great risks.

It is possible that, by extended mobilization of the duodenum, it will be

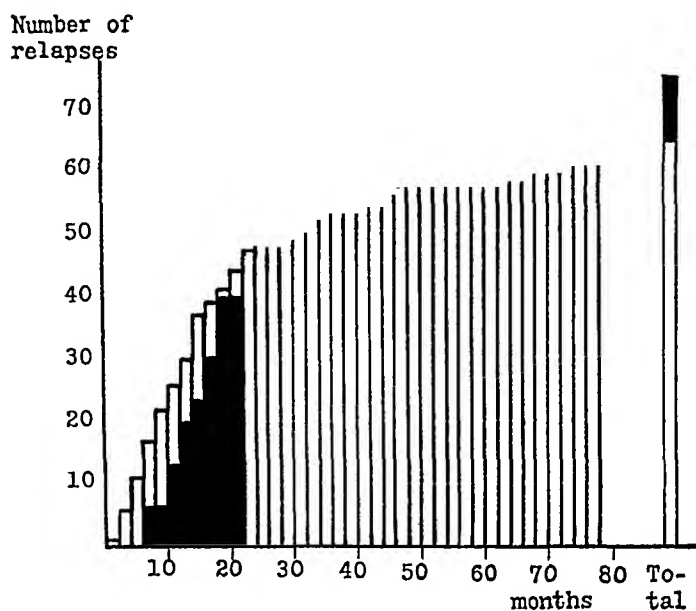


FIG. 21.—Each column stands, in horizontal direction, for a space of two months. From the operation, which is supposed as being placed in *origo*, to the last column in the series drawn, there has, consequently, elapsed a space of six and one-half years. The tops of white columns show the absolute number of relapses after resection for adenocarcinoma, etc.; that of the black ones, the number of relapses after resection for scirrhus tumors, after reduction from twenty-two to seventy-four in order to obtain a better comparison.

## VI. CANCER TYPES AND LATE RESULTS

It has gradually become an axiom that the fibrous forms of cancer of the stomach are more benign than other forms. Kausch<sup>4</sup> says in this respect: “. . . die fibrösen Formen scheinen nach der Radikaloperation weniger leicht zu rezidivieren und weniger zu metastasieren.”

If we examine our material in this regard, we shall find that this is not at all the case.

Of the cases surviving the operation, where the operation took place more than five years back, and of which we possess a detailed histological special diagnosis, 22 are scirrhus carcinomas, and 74 of other types, cancer medullare et simplex, cancer gelatinosum et colloides, and adenocarcinoma.

Not one of the 22 scirrhus cases has been relapse-free, while among the 74 cases of adenocarcinoma, etc., 10 (13.9 per cent.) have escaped a relapse.

On the other hand, it has undoubtedly been the case that the scirrhus tumors have relapsed more slowly than the other cases.



## FINAL RESULTS OF GASTRIC RESECTIONS FOR CANCER

Of the 22 relapses which followed the resection of scirrhus cancer, none has resulted in death within the first one-half year, and only 4 within the first year. Of 64 relapses after adenocarcinoma, etc., 11 patients have died within the six months and 26 within one year.

The diagram in Fig. 21 is intended to illustrate the tendency to relapse which has been shown in this material, in the case of scirrhus tumors, on the one hand, and of adenocarcinoma, etc., on the other.

It is shown immediately by the diagram that, during the first two years after operation, the tendency to relapse, in the case of adenocarcinoma, etc., proved to be considerably greater than in that of scirrhus tumors. At the beginning of the third year, this condition of things began to change, and from that point the number of relapses rises for the latter class more rapidly than for the one first mentioned.

The single column shows graphically the higher, total tendency to relapse in the case of scirrhus tumors. Expressed in per cent., the relapses in the case of scirrhus tumors, as compared with those in other classes, have been as 100:86.1.

Although *scirrhus carcinoma* ought, undoubtedly, to be of a *biologically more benign character* than other cancers of the stomach, it has, in our material proved itself, *practically speaking, more malignant*.

Possibly, the explanation is to be sought for in the fairly customary disposition of scirrhus tumors to show symptoms at a late period. The diagnosis is frequently not made until the tumor has spread to great dimensions in the wall of the stomach. Microscopically, too, the tumor infiltration, in most instances, often extends beyond the palpable limits of the tumor; in many instances to a fairly great degree. If microscopic rests of cancer happen to be left on resection, then relapse occurs, but this appears at a somewhat late date, just in consequence of the special biological features of scirrhus.

It should, then, in the case of scirrhus tumors, too, be of extreme importance to remove a large part of the stomach, far beyond the macroscopic limits of the tumor.

### VII. SUMMARY AND CONCLUSION

This investigation is based on a material of 1150 cases of gastric cancer which were operated on at the Seraphimer Hospital during the period 1887-1926.

Cancer cardiae is not included.

Three hundred and sixty-one cases were resections; their operative mortality was 28 per cent.

Four hundred and fifty cases of gastro-enterostomy; operative mortality 23.1 per cent.

Three hundred and thirty-nine exploratory operations; operative mortality 17.1 per cent.

Resection has been performed on 210 men (operative mortality 32.9 per cent.) and 151 women (operative mortality 21.2 per cent.). Thus, considerably higher mortality in men.

During the last two and one-half decades, the operative mortality has exhibited an evident increase; from 20 per cent. (1902-1906) to 38 per cent. (1922-1926).

The causes of this are: (a) Extended indications for resection, and (b) a great displacement of the material from feminine to masculine majority (Fig. 4).

An evident parallelism is shown between the operative mortality and the number of resections in per cent. of the total number of verified cancer cases in different time periods. The number of technically easy cases has been steadily decreasing (see table on page 325).

In 19 cases (all, excepting 4, belonging to the last fifteen years), it has been necessary to perform, simultaneously, colon resection. Eight (42 per cent.) died in connection with the operation.

Seventy-one patients, or 19.6 per cent. of the total number operated, have died of abdominal complications; 18 (5 per cent.) of pulmonary, 12 of which pneumonias in patients, except one, above sixty years of age. In addition, 12 patients died of complications of a more accidental character.

Of 71 abdominal complications, 1 was intra-abdominal bleeding, 2 necrosis of pancreas, 42 diffuse, and 16 circumscribed peritonitis, 7 cases of ileus and, finally, 3 post-operative fistulas, with marasmus. Suture insufficiency was proved in 23 cases.

Billroth I and Polya have contributed a considerably worse immediate operation result than Billroth II.

On examining the durability of the results, respect has only been paid to cases which had been operated on more than five years ago. Two hundred and sixty-nine cases operated on; 66 died primarily; 3 not found.

Of 200 surviving cases, there died within five years 161 (80.5 per cent.), viz., 61 the first year, 61 the second, 26 the third, 9 the fourth, and finally 4 the fifth year. All these except 2, most certainly died of a relapse.

*In addition, 12 patients died of a relapse later than five years after operation.* In all these cases, except one, the cancer was localized to pylorus, or its immediate neighborhood. In one instance, the tumor was situated in major curvature and mesocolon. Only in one instance did there exist cancer regionally in the lymphatic glands. In all these cases of late relapses, had the patient been subjectively well until a few months before death. The patients lived from five years and four months to seventeen years after operation. None of these patients was operated on according to Billroth I.

*Further, 9 patients have died of some other disease later than five years after operation.* The causes of death in all the cases has been stated by medical men, in 6 of the instances at the hospital where the patient died. One or two of these cases seem to me, nevertheless, suspect to have been cancer relapses, too.

*Eighteen patients are still living, 17 of them well,* seven to twenty years after operation. One patient operated according to Kocher, all the others according to Billroth II and Polya. Several of the tumors were large, one of them going on to the transverse colon, which also had to be resected. One tumor was 12 cm. long, and extended up to the vicinity of cardia. Subtotal gastrectomy had to be performed. In none of these 18 cases had cancer been proved in the regional lymphatic glands removed. In all the cases except 4, the clinical post-examination could be supplemented by X-ray examination.

It is remarkable that, among the relapse-free cases, there are several rather advanced ones, while, among the late relapses, there were found scarcely anything else than moderately advanced pylorus tumors.

*One patient has, on two occasions, been subjected to resection, at an interval of three years.* He is still alive, and is subjectively and objectively well, almost three years after the last operation.

From the point of view of the durability of the results, Billroth II and Polya have shown themselves to be absolutely superior to Billroth I, transverse resection and Kocher. Scirrhus tumors have proved to show a greater relapse tendency than the other forms of gastric cancer. None of those surviving the operation for scirrhus tumor, have remained relapse-free, while, of the other cases, 13.9 per cent. have not had a relapse.

In June, 1890, Th. Billroth and his assistants<sup>2</sup> had already performed 29 pylorus resections for carcinoma, with 16 primary deaths. Billroth says at the close of his lecture at the International Congress in Berlin, 1890:

" . . . ist doch wiederholt gegen diese Operationen wegen Carcinom geltend gemacht, dass bisher noch kein Fall von radikaler Heilung eines Magen- oder Darmkrebses durch die Resektion vorliege (nur eine Frau überlebte die Pylorus-resektion wegen Carcinom 5¼ Jahre), und dass der Wert solcher Operationen beim Carcinom daher sehr problematisch sei; dass auch in den meisten Fällen die Diagnose erst dann sicher zu stellen sei, wenn der Fall nicht mehr mit Aussicht auf Erfolg operiert werden könne. . . . Wer aber das Aufblühen solcher Kranken nach Beseitigung der Pylorus- und Darmstenosen durch Carcinom erlebt hat, wird nicht daran zweifeln, dass diese Patienten den Theil des Lebens, welcher ihnen überhaupt noch vom Fatum bestimmt ist, in weit angenehmerem, erträglicherem Zustande verleben. als wenn sie nicht operiert wären. Auch in dieser Beziehung nehmen also diese Carcinomoperationen keine Sonderstellung ein. Der Unterschied liegt bisher nur in der *Schwierigkeit der frühen Diagnose und in der Gefahr des operativen Eingriffes*.—Ich hoffe, dass beide Momente keine unheilbare Gebrechen unserer Kunst bleiben werden. Ich zweifle nicht daran, dass bei fortgesetztem eifrigem Studium eine frühere Präcisirung der Diagnose möglich werden wird, und dass wir die Gefahren dieser Operation durch Vervollkommen der Methoden und der Technik um ein Bedeutendes zu verringern im Stande sein werden . . . "

Has the prophecy of the great precursor been fulfilled? Yes, undoubtedly, to a not unimportant degree. Many are the statistics who have shown a five years' freedom from relapse amounting to 20 per cent. and thereabouts, of the surviving cases operated. But, as the greater number of the cases of gastric cancer cannot at all be subjected to resection, and as, in addition, the majority of the resected cases die in connection with the operation, or from a relapse during the years immediately succeeding the operation, we are as yet unable to say that resection of stomach has very emphatically proved to be an ideal weapon in the combat against gastric cancer. Many are they who, following Billroth, have pointed out the importance of an earlier diagnosis. Great, too, is the number of those who have clearly seen and pointed out the limits for the possibilities of an early diagnosis, viz., the, in many instances, lingering course of cancer of the stomach, and its long period of latency. Röntgen examinations have extended our diagnostic possibilities in an unheard-of degree, but, just by doing so, they have also increased our operative indications to cases which are even more difficult, technically. And it is just for this reason that the decrease in primary mortality, which Billroth hoped for, have not, as yet, by far, from a percentage point of view, been attained. But it is certain that a more extensive employment of the operative treatment of cancer of the stomach has been the result. *And in this way, most certainly, the improved diagnostics, hand in hand with the also improved technics, have tended to an increase in the number of those who have to thank a successful operation for their lives.* Nor ought we to forget those who have had their existence prolonged by a few or many years of good health. As we have seen above, the number of these patients is much greater than that of those radically cured.

But mankind awaits with impatience a better remedy against cancer, cancer of the stomach included, than the knife of the surgeon.

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# THE COLLOIDAL LEAD TREATMENT OF MALIGNANT NEOPLASMS \*

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THERE is little in the literature to confirm the results obtained by Blair Bell from the intravenous injections of colloidal lead in the treatment of malignant neoplasms. His theory, also, regarding the selective action of lead upon trophoblastic cells and hence of tumor tissues in general, although it has been a subject for research among numerous workers, remains to be proved. It is unfortunate that his emphasis upon the danger of the clinical application of his method has not been accompanied by fuller details of the making of his preparation and its administration, and by a more complete description and analysis of the toxic effects and clinical results. Wood has done much in this country to interpret Blair Bell's theories, but his own experimental work on animals has tended to disprove the conception of the selective action of lead upon tumors. Martland's work, also, from the treatment of 15 patients, appears to disprove this theory. Using, apparently, a very stable preparation of colloidal lead, he was able to inject very large amounts without producing any serious immediate toxicity. Subsequently, however, serious lead poisoning resulted, and from the autopsies in 8 cases, the lead was found in large amounts in the liver, bone-marrow and, especially in the spleen, which contained twenty times more than the primary tumors and forty times more than was found in the metastases. Also, whenever traces of lead were found in the tumor, it was always in the "histiocytes" of the stroma and not in the tumor cells. Martland interpreted his findings to mean that the particles of lead were retained in the body by being picked up in the reticulo-endothelial system and later, after large amounts had been injected, the lead began to be paid out slowly in a toxic form into the circulation. He obtained apparently, no favorable clinical results, and they would hardly be expected from the type of tumor selected in some of his cases and from the advanced stage of the anæmia and cachexia which existed in others. The literature contains a considerable amount of discussion of the effects of lead poisoning upon the gestations products in both animals and the human subject (Paul, Hanzlik, Ovi). Dilling states that lead has a definite non-specific action on growth, like other metals, and that there is evidence of lead having

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\* This work was carried on in the Memorial Hospital of New York. The preparation of the lead was made in the chemical laboratory by Dr. H. Q. Woodward. The blood and urinary examinations were made in the Pathological Laboratory under the direction of Mr. E. C. Ellis. Clinical assistance was given by Dr. Max Cutler, Dr. J. W. Spies, and Dr. H. Copeland.

greater power than other metals of inhibition on the germination of cells, or of retarding the growth of embryonic tissues in strength not toxic to more mature tissues. There is nothing, however, to verify, specifically, Blair Bell's conception. Eising, in an editorial review, suggested that, possibly, the metallic colloids, having an intense affinity for oxygen, may act through this affinity and establish a local starvation of the tumor cell. Wood has given a brief résumé of the work that has been done with other metals. Notable among these workers was Weil, whose work at the Memorial Hospital with copper produced entirely negative results. Ochsner appears to have observed some favorable clinical results from colloidal gold, but this judgment seems to be based largely upon reports from the patients, their relatives, or local physicians. Such a method, however, does not furnish a basis for scientific study, but it has always been popular, especially among those exploiting so-called cancer cures. In regard to the use of lead as a constitutional remedy, it is of interest to find that its efficacy as a local agent was first proposed by Goulard in France in 1750, who based the evidence of its value upon the reports of a few cases made by the patients themselves, in some of whom there is not sufficient evidence, to show that a malignant growth existed. However, it evidently attracted wide attention, because Goulard's monograph was translated by Armand into English and ran into three editions. It may, also, be evidence of its wide acceptance at that time that the name of "Goulard's Extract" was given to "liquor plumbi subacetatis" in the British Pharmacopœia. A few observations recently made by the present writers suggest that it may have some value as a local application to ulcerating neoplasms. The value of colloidal lead as a constitutional agent is attested by only a few case reports. Coke and Cook, in England, using smaller doses than Blair Bell and a more stable suspension, report a few favorable clinical results. In this country, Wood has evidently observed improvement in a few cases, but he has made no formal report of his results. The case reported by O'Crowley of an epithelioma of the penis, treated by both lead and surgery gives no facts to prove or disprove the value of lead. Also Bulkley's assumption of a "Death from Blair Bell's Colloid Lead Injection" four weeks after the beginning of treatment is not justified by the facts that are reported. It is plain, therefore, that the use of colloidal lead for the treatment of malignant neoplasms is in an experimental stage.

The observations of the present writers have been made at the Memorial Hospital during the past eleven months in the course of treatment of 21 patients with the following lesions: Carcinoma of the breast, 7; malignant bone tumors, 5; carcinoma of the uterus, 3; carcinoma of the rectum, 1; angiosarcoma of the mouth, 1; malignant retroperitoneal tumor (pancreas), 1; metastases of a malignant tumor of the (testicle?), 1.

*The selection of cases* has been made entirely from the standpoint of the safety of the patient, presuming that some lead toxicity is necessary in order to obtain any favorable clinical results. Excluding, of course, all cases favorable for cure by surgery, and, also, all cases such as lymphosarcoma or the

metastases from teratoid tumors of the testicle, in which radiation is now generally known to produce favorable results, we have limited our cases to those in which the disease is well advanced. Of these, however, we have tried to exclude those apparently in the terminal weeks of the disease, or those in which anæmia, cachexia and the general condition are such that the introduction of a poisonous agent would apparently be a hazardous undertaking. Our attention has been directed to the advice of Blair Bell that cases should be excluded in which the lungs, liver and kidneys are involved by either disease or tumor. Our observations, however, indicate that in the selection of cases such precautions may be prudent, not because these organs have shown any special selectivity for the lead, but because either metastases in these organs may indicate that the disease is too far advanced, or we would expect a poison introduced into the circulation to require a fairly normal state of the liver and kidneys for its proper excretion. It is for these reasons that so far we have not accepted cases having tumors which otherwise we would like to treat, such as gastric cancer, of which no case has yet appeared in which the general condition of the patient has seemed to us to justify the trial of this method. It may be that the field for the use of lead may be widened in those cases in which anemia appears to be the only objection to its use by a more frequent resort to a preliminary transfusion than we have thought it was best to do in this series. We have resorted to this procedure as a preliminary measure in only two cases, in both of which it appeared to be of considerable assistance. If, however, the anemia is combined with a marked cachexia, we doubt its advisability, for we have not yet forgotten the failure of transfusions to meet the situation created by the enthusiastic efforts to apply the so-called massive doses of high voltage X-ray when it was first introduced from Germany. Similar failures will follow the use of lead unless due caution is used in avoiding the treatment of patients in the terminal weeks of the disease.

The dosage of lead, the formula and the intervals of its administration are matters of extreme importance, about which there appears to be at present considerable confusion. Our preparation, which has been made in the chemical laboratory of the Memorial Hospital by Dr. H. Q. Woodward, is as follows: The colloidal lead was prepared by maintaining an electric arc between lead electrodes immersed in a .00022 normal potassium hydroxide solution. The apparatus consists of a 600 Pyrex glass beaker containing the positive and negative electrodes. The positive electrode is a sheet of commercial lead covering the bottom of the beaker and a strip of lead leading up to the top of the beaker. The negative electrode is a roll of C. P. lead foil attached to a screw feed. The beaker is covered with a mica cover perforated to admit the passage of the negative electrode and of a glass tube and a thermometer. The beaker is immersed in an ice bath. A voltmeter is connected in parallel with the arc.

In preparing the colloid, the potassium hydroxide solution is boiled, the beaker is immediately transferred to the bath, and the positive electrode and

mica cover put in place. The thermometer is adjusted below the surface of the solution and the end of the glass tube just above the surface. A stream of air freed from carbon dioxide by washing with strong potassium hydroxide solution is passed through this tube over the surface of the liquid during the entire time the apparatus is in use. Ice is added to the bath containing the beaker until the temperature falls to 20° C. The current is then turned on and the arc established and maintained by manipulating the screw feed of the negative electrode. The rheostats are adjusted so that the current flowing across the arc is 1.4 amps. and the potential drop 40 volts. The temperature during arcing is continued until 1–1.5 g. of lead has disintegrated from the negative electrode per 100 c.c. of sol formed. The positive electrode does not disintegrate appreciably. The colloid is then transferred immediately to 50 c.c. centrifuge tubes and centrifuged for five minutes with a force of 1000 X gravity. Samples are withdrawn for analysis by the colorimetric sulfide method, and the tubes closed at once with an airtight paraffin seal. Sols so prepared have an average concentration after being centrifuged of .130 lead, with an average deviation from this value of  $\pm 11$  per cent. These sols have kept for four weeks without coagulation; and sols ranging from two hours to nine days have been used for intravenous injections. These sols differ from those described by Blair Bell in being less concentrated and in containing no gelatine or other protecting agent, except that in the sol prepared for the first injection .4 per cent. of gelatine was used, but thereafter omitted because of the immediate reaction that followed. The sol after being prepared is not sterilized, for the entire procedure is done under aseptic conditions, and it is also itself antiseptic. Numerous specimens so prepared for injections have been tested and found to be sterile. This sol, also, is evidently more stable than that used by Blair Bell and does not require its immediate use. No difference clinically has been observed in our cases whether it was used on the day of preparation or nine days later. We are unable to make further comparisons of this sol with any other because it is the only preparation of lead that we have used. Whether its stability, as compared with Blair Bell's is an advantage beyond the added convenience, it is impossible to state, but the favorable results obtained by Coke and Cook with more stable sol suggest that results may be obtained with a less amount of toxicity than that observed by Blair Bell.

The dosage of lead and its administration can only be discussed from the use of our own preparation. We found that we were unable to follow the suggestion of Blair Bell that to obtain the most favorable results, it was best to inject a total of 600 milligrams within a period of two or three months, using 100 milligrams at each injection if we were to adhere to the principle upon which we began the work of considering the comfort and safety of the patient without regard to the effects produced upon the tumor tissues. Upon this principle, therefore, we first tried to use an amount at each injection which would not produce severe reactions, and then determined the intervals between the injections by the recovery of the patients from the



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clinical symptoms, especially anemia, produced by the previous injection. In two cases in which we used 100 milligrams at intervals of seven days, the reaction, although transitory, was more than what we regarded as safe. In adults, therefore, according to their general condition and body weight, we have varied from 50 to 90 milligrams at each injection, not using more than 100 in any case. Our largest total amount in any case has been 375 milligrams extending over a period of four months at varying intervals. The intervals in different cases have varied from five days to four to five months. It may be that we might have shortened the intervals between injections by a more frequent resort to transfusions, for after fifty-six injections this procedure has only been done seven times, and in only one instance because a real emergency arose from the extreme anemia. One patient received three transfusions—a case of chorio-epithelioma, which we were most anxious to treat because of Blair Bell's theory of its probable susceptibility, and, although the fall in the number of red cells after the injections was not extreme, the patient at the beginning had a marked anemia and was bleeding from the vaginal tumor. Ordinarily, we would not have accepted the case for the lead treatment. Regarding the actual amount to be used at each injection, we have calculated that not over 1.5 to 2.0 milligrams of lead, as prepared by our formula, per kilogram of body weight may be regarded as a safe guide and is the amount which has produced the results which we have so far obtained.

*The clinical signs of lead toxicity*, as observed after fifty-six injections in 21 cases, were severe in four instances, pronounced but not alarming after five injections, and mild, occurring transiently with one or two symptoms in all of the others.

*During and immediately following the injections*, there was only one reaction which appeared to be alarming, beginning twenty minutes after the completion of the first injection of only 10 milligrams in the first patient treated. It began with a severe chill, followed by a rise of the temperature to 103° F. with a rapid and feeble pulse, cyanosis and a state of complete collapse, but quickly subsided after an intravenous injection of adrenalin. In this first preparation of the sol .4 per cent. of gelatine was used, but has been omitted from all of the subsequent preparations, and no more reactions of that kind have been observed. Subsequently, in the same patient 30 milligrams of lead were injected without the gelatine and no reaction occurred. With this exception, then, there have appeared no serious symptoms during or immediately following the injections. There appears to be little effect upon the quality or rate of the pulse during the time of the injection, which has varied from two to twelve minutes. In twelve instances the pulse rate was accelerated from fear or excitement at the beginning, and in seven cases became less frequent and of better quality at the termination. In fourteen instances there was a slight decrease in the volume, which, however, required no medication except in four. During twenty-one injections toward the finish there were subjective sensations of tingling or burning, especially

about the lips and face. Eight patients noted a metallic taste which in two persisted for several hours. After four injections the patients remarked about some obscure sensations in or about the tumor, in no instance amounting to actual pain. Near the finish of the injection nausea occurred four times—in three of vomiting.

*During the First Twenty-four to Thirty-six Hours.*—The only three severe reactions from the lead which occurred in this series began within six to fourteen hours after the injection—two having hæmaturia and jaundice, in one of which there was marked swelling of the liver. In one case having severe dyspnœa and prostration with a rapid and feeble pulse, the reaction appeared to be an exacerbation of similar attacks which had occurred prior to the injection, and was due to the terminal period of a pleurisy with effusion from metastases of a carcinoma of the breast, from which she died five weeks later. In the third case, also, having severe dyspnœa and prostration for the chief symptoms, the reaction was associated with a large collection of fluid within the pleural cavity and pulmonary metastases from a carcinoma of the breast. The recovery from the reactions was prompt in all of the cases, except the one having the swollen liver, in which the anemia became so severe within five days that a transfusion was done and was followed by a prompt and satisfactory recovery from all of the symptoms. Sharp reactions occurred in five other cases, characterized by nausea, vomiting, rapid pulse and considerable prostration, which, however, lasted only a few hours except in two cases in which nausea and vomiting persisted for two days. Milder reactions occurred in practically all of the other cases during the first twenty-four hours and lasted a few hours. They were characterized by one or two symptoms—nausea and vomiting, 28; abdominal cramps, 10; dizziness, 5; headache, 4; transient hæmaturia, 2. There was a rise of temperature following twenty-two injections from 99 to 101, which lasted only a few hours except in two cases having markedly infected tumors in which the temperature persisted for several days.

*Subsequent Course and Symptoms.*—Except for the anemia, a few instances of nausea and vomiting and abdominal cramps and a transient jaundice, the recovery of the patients from the effects of the lead toxicity was rapid and apparently complete. A consideration of the toxic effects upon the individual organs confirms also the temporary nature of the toxic effects.

*The Gastro-intestinal Tract.*—There was hardly a case which did not have occasional attacks of nausea and vomiting, but there were only two instances in which a prolonged disturbance of this nature occurred, beginning several days after the injections and persisting for two days in each case and without any sign to indicate a special cause. Loss of appetite persisting over a period of two weeks was not uncommon but finally disappeared. Constipation did not appear to be more common than we ordinarily observe in other patients and therefore did not appear to be related to the lead poisoning. Abdominal cramps, or lead colic, was not so frequent a symptom

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as it is reported to be in the literature of chronic lead toxicity, but after four injections it was a prominent symptom, and in one case it offered an annoying complication over a period of ten days. In the same patient it reappeared after a subsequent injection, but less severely and for a shorter time. It was not associated with a severe constipation and was relieved by saline catharsis and a higher calcium intake in the food and by the administration of calcium lactate.

*The liver* did not appear to have been seriously injured, enlarging sufficiently to become palpable in only one case, and disappearing promptly as did the jaundice which occurred in five other cases.

*The kidneys* also, as determined by the urinary findings, were not affected apparently beyond the state of an acute congestion. The urine was negative before the injections were begun in 15 patients, and in the six whose urine showed a trace of albumen and in the one with casts also, the urinary findings after the injections were no worse than in those in which the urine had been negative. Of the 15 cases showing negative findings prior to the injections, following 40 injections, there were only four which did not show either a trace of albumen alone or both albumen and casts at some period during the course of the treatments. There was albumen alone in 22, and 14 had both albumen and casts. In 12 the albumen appeared within the first twenty-four hours, and in 24 within the first three days following the injection. Casts appeared within the first twenty-four hours after four injections, and after eight within the first three days. Hæmaturia appeared on the first day after three injections and on the third day in a fourth case. There were no signs of permanent injury to the kidneys. Both albumen and casts disappeared within a few days, and in cases receiving from three to five injections, they did not always reappear after being present after the first injection; even in cases with hæmaturia, it did not reappear after subsequent injections.

*The lead line* on the gums sufficient to be easily observed was always associated with infected gums and teeth, and unless these were badly infected the line disappeared under proper hygiene. It was observed in eight cases after the first injection of 80 milligrams of lead, appearing in the earliest on the fourth day after an injection of 100 milligrams.

*The Blood Changes.*—The destruction of red cells began within the first twenty-four to thirty-six hours and made the chief difficulty in the clinical application of this method of treating malignant neoplasms. The maximum loss in red cells was 1,888,000 within two days, and the minimum 240,000 within seven days after a single injection. After fifty-one injections the average loss after each injection was 977,000, with little difference between the first and subsequent injections. The rapidity of the loss varied somewhat with dosage, reaching the lowest point after twelve injections within three days, after twenty-eight injections on the seventh day, and after thirty-six on the tenth day—the longest time being forty days. The lowest number of cells was 1,500,000, occurring on the fifth day after a second injection of

100 milligrams at an interval of only seven days. The rapidity of recovery in the number of red cells did not always vary with the severity of the loss—the recovery after the maximum losses often being comparatively rapid and satisfactory. The rapidity of recovery practically determined the intervals of treatment. For example, in one patient receiving five injections, the intervals were twenty-seven, fifty-two, twenty-three, and thirty-eight days, making a period of four months. In another, a child of five years of age, receiving four injections, the intervals were nine, thirty-three, and twenty days, making a period of two months.

*Stippling* occurred almost as uniformly as the decrease in the number of red cells, there being only two cases in which stippled red cells did not appear at some time during the course of the treatment. In one of these, only two injections totalling 40 milligrams were given: in the other only one injection of 80 milligrams. After nine injections the stippling was first observed within forty-eight hours, in four cases it did not appear until after the second injection, and in three not until after the fourth. The maximum number of stippled cells, occurring in four cases, were three to five in a field. In the others, they varied in number from one in the entire smear to three to five in ten or fifteen fields. In two instances they were described as coarse, but apparently without any clinical importance. Nucleated red cells appeared in eight instances—in three to a considerable number, and in four cases they were stippled. Poychromatophilia was observed in ten cases, amounting to a large number in three, and in two without stippling. In general, the stippling varied with the dosage and the severity of the anemia, diminishing in number with the recovery from the anemia. It often persisted, however, in an occasional cell after recovery from the anemia, remaining as the sole evidence of the lead toxicity. Another injection was often given while stippling was still present and it was not regarded as of the same clinical importance as the number of red cells. Regarding the white cell count, there was a transient and moderate leucocytosis, varying from 11,000 to 21,000 in ten patients, which in five instances was associated with infected tumors. In the others the increase in the number of white cells appeared to occur at the height of the more pronounced reactions, but it was not connected with a disturbance in the normal relations of the differential count, except in one patient in whom an abscess formed in an actively growing tumor.

*Toxic Effects of the Lead upon the Health of the Patients.*—We have observed that all of the signs of serious toxicity have appeared and disappeared within a few days after the injections have been given except the anemia, occasional nausea and vomiting and abdominal cramps, which also have disappeared before subsequent injections were given. As a result fifteen are living and six are dead. Of the latter, three lived from seven to ten months after the injections and three only six, five and two weeks, respectively. But even of those dying shortly after the injections, each had recovered from the effects of whatever lead toxicity they had shown, which

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had been severe in only one case. Two died under the clinical setting of a pleurisy with effusion from the metastases or carcinoma of the breast. The other also has pleural metastases in addition to rapidly and widely disseminating tumors of the abdomen from a transitional cell carcinoma of the uterus. Of the three patients who lived a longer time, the disease progressed without any signs of the lead having a permanent effect upon the general condition. Striking evidence of the transitory nature of the lead toxicity is shown in four patients whose treatment was abandoned because of the apparent failure to affect the tumors. All have gained in weight and strength and are in better general condition than when the injections were begun. One of these cases was relieved markedly from pain.

*Effects Upon the Tumors.*—We have considerable evidence to show that the intravenous injection of colloidal lead, used either alone or in combination with radiation, can produce sufficient regression in certain types of tumor to confirm in part at least Blair Bell's results. In four out of seven cases of mammary cancer which received this treatment, appreciable regressions of the tumors occurred and in two cases the results might be designated as a temporary "clinical cure."

CASE I.—*An advanced ulcerating cancer of the breast, axilla and neck with multiple metastases to the pelvic bones and a pathological fracture of the right femur.* She was admitted to the hospital, suffering severe pain and marked prostration two months after the completion of a series of X-ray treatments, which had failed to stop the progress of the disease. All of the tumors had increased in size and the pathological fracture had been a recent event. Five days after the first injection of 90 milligrams of lead a softening and oedematous feeling of the tumor of the breast was observed, and within twenty days there was a definite regression of the tumors in the breast, axilla and neck. Pain, also, had disappeared, and the patient's general condition was improved. Twenty-seven days after the first injection a second of 75 milligrams was given, and two months after the first injection the soft part tumors had completely disappeared. Two weeks later—two and a half months after the first injection—an X-ray examination showed a regeneration of all of the bone lesions. During the third month two more injections of 75 milligrams each were given, followed in the fourth month after beginning of the injections by a steady gain in the general condition, no evidence of soft part tumors, and a continued and marked regeneration of all of the bone lesions, including a union of the pathological fracture. During the fifth month a final injection of 75 milligrams of lead was given, followed by a constant gain in every way for two months, when another metastasis appeared in the outer end of the right clavicle. At that time the red cell count was 4,200,000 and without any stippling. In view of the report by Hunter and Aub showing that by means of parathyroid extract—Collip lead, which is stored in the bones, may be mobilized along with the calcium, we administered Parathormone on several occasions to this patient. We hoped that in this way it might be possible to make use to some extent of the lead which had already been stored in the bones, and thus avoid subjecting the patient to further injections of lead. We did not analyze urine or fæces for lead, and are therefore unable to state whether the excretion of lead was increased. However, there did appear to be a distinct tendency for stippling to reappear following each period of parathyroid administration. While our dosage was small—10 units twice a day at first, and later three times a day—it was sufficient to increase the blood calcium to 15 mg. per 100 c.c., which is stated to be the maximum safe limit for the human subject. (McCann.) The radium pack was then applied and followed by a prompt regression which is not yet complete. Her general health

continues to improve without any signs of recurrence of the old tumors. This patient received 375 milligrams of lead within a period of 139 days—the largest amount that has been given to any patient.

CASE II.—*An advanced ulcerating cancer of the breast, axilla and neck.* No other metastases were found and the patient, although having lost considerably in weight, was not markedly cachectic. She had a moderate amount of pain. After two injections one week apart, of 100 milligrams each, the most severe reaction that we have observed occurred, characterized by nausea and vomiting, hæmaturia, jaundice with a marked swelling of the liver, and severe prostration. A rapid recovery, however, followed a transfusion. Three weeks after the first injection, a definite regression of the tumors of the breast, axilla and neck was observed, presenting the same cedematous feeling of the tissues which were observed in the first case. Six weeks after the first injection the ulcer showed signs of healing and the regression of the tumor in the breast appeared to be almost complete—possibly it was complete. Two X-ray applications were made, however, and all of the tumors completely disappeared and the ulcer healed. The regressions appeared to remain complete for two months, when a diffuse infiltrating tumor appeared in the other breast. A third injection of 75 milligrams of lead was given, without any reaction such as we were afraid might occur because of the severity of that which followed the second injection. A rapid regression resulted but did not become complete until an application of X-ray was made. Since then there has been observed no growth activity of the tumors. At least, there has been no gross evidence of existing tumors with the exception of numerous small discrete skin nodules which appeared on the chest wall near the periphery of the primary tumor during the eight months after the beginning of the treatment. A fourth injection of 75 milligrams of lead did not affect apparently these nodules until after an application of the radium pack. Since then all of them have disappeared. The patient's general condition has improved and now, almost one year since the beginning of the treatment, she presents no evidence of tumor.

CASE III.—*An advanced cancer of the breast with extensive metastases of the pleura and lungs,* from which she died five weeks after one injection of 75 milligrams. There had been complete recovery from the effects of the lead. A definite regression of the breast tumor was observed within one week after the injection, but there was no observable effect upon the progress of the pulmonary metastases.

CASE IV.—*Cancer of both breasts, axillæ and neck,* with marked cachexia, admitted to the hospital two months after the X-ray had failed to alter the progress of the disease. On the third day after a second injection of only 10 milligrams of lead, given five days apart, a definite line appeared on the chest wall, showing the flattening out of skin nodules within the area that had been treated by the X-ray as compared with the nodules outside of this area. No other evidence of the effects of the lead were observed, and the patient died six months later from the extension of the disease.

CASE V.—*Osteogenic sarcoma of the humerus.* A girl, fourteen years of age, presented an advanced lesion of the upper end of the humerus, which gave all of the clinical and radiological signs of a typical osteogenic sarcoma. The bone was so much destroyed that a pathological fracture had occurred and there was a bulky soft part tumor. Five days after the injection of 50 milligrams of lead the tumor began to soften. Radium was applied and three weeks after the injection pain had entirely disappeared and the tumor had become cystic throughout. Another injection of 50 milligrams was given four weeks after the first. Four days after this injection the tumor began to decrease in size, and continued to do so rapidly until two months after the first injection the soft part tumor had entirely disappeared. The X-ray examination at this time also showed well-marked bone production and healing of the fracture. Six weeks after the first injection the X-ray showed a small nodule in the lung which had disappeared apparently three months later. Four other injections of lead were given until a total of 354 milligrams had been given over a period of 157 days. Other radium

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and X-ray treatments were given, and the patient has continued to gain in health until the present time, six months since the beginning of treatment. There appears to be union of the fracture, marked regeneration of the bone, and no evidence of a soft part tumor.

CASE VI.—*Osteogenic sarcoma of the femur.* A man, twenty-six years of age, applied to the hospital with a bulky tumor of the thigh which was found to be a typical advanced osteogenic sarcoma of the upper end of the femur. There was marked destruction of the bone and a pathological fracture. Two injections of 90 milligrams of lead at an interval of eighteen days were given, and two weeks after the second injection there had been no improvement. The soft part tumor, in fact, had increased in size and pain also had become much worse. The radium pack was then applied and almost immediately the tumor began to decrease in size, pain disappeared and within three weeks there was no evidence of a soft part tumor. The X-ray showed also a beginning regeneration of the bone. Two more injections of 90 milligrams have been given, and the patient is steadily improving in health, but is confined to his bed because the union of the fracture is not yet completed.

CASE VII.—*Osteogenic sarcoma of the rib.* A man, fifty years of age, presented a large semi-solid tumor of the chest wall. The X-ray examination showed an area of destruction of the ninth rib, with the typical picture of an osteogenic sarcoma. An exploratory operation had been done two months prior to admission. The tumor had grown rapidly since the operation and showed all the signs of infection. X-ray treatment failed to produce any changes. After two injections of 90 milligrams of lead, given at an interval of fourteen days, the tumor became definitely smaller, but has not decreased so rapidly as in the two previous cases. It is too early, however, to judge of the outcome. The treatment will be continued by the combination of lead injections and radiation.

CASE VIII.—*Ewing tumor.* A girl, five years of age, weighing thirty-one pounds, presented a bulky tumor of the left leg, upon which an operation had been done a few weeks previously under the diagnosis of osteomyelitis. The fibula was found to be the site of an endothelial myeloma. A large part of the fibula was excised with a tumor of the soft parts. It had recurred promptly and upon admission there was a bulky tumor of the soft parts and an actively growing tumor of the ends of the fibula. On December 3, 1926, a radium application was made and one week later 25 milligrams of lead were injected into a vein of the neck. The tumor completely disappeared eighteen days after the lead injection. The next day—nineteen days after the first—another injection of 33 milligrams was given, which was followed by a transient hæmaturia and pallor, but all of the signs of a lead reaction rapidly disappeared. Three weeks later the X-ray showed a marked regeneration of the bone. During the next month two other injections of 25 milligrams were given without any reactions, making a total of 108 milligrams given within seventy-three days. The patient has continued to gain in weight and strength and has remained without any appreciable evidence of tumor until the present, nearly five months since the beginning of the injections.

*Discussion of the Results.*—We have therefore observed regressive changes in the tumors of eight patients out of twenty-one who have received the lead injections either alone or in combination with the applications of the X-ray and radium. In two cases, however, the changes were transient and exerted no influence upon the course of the disease. One of these—a cancer of the breast, showed a definite regression of the primary tumor, shortly after the injections of lead alone, but had no apparent effect upon the metastases and the course of the disease. The other, also a cancer of the breast, showed regressional changes in the skin metastases where the



X-ray had been applied previously, but manifested no other changes. Such observations by themselves have little significance, but in connection with the greater effects observed in the six other cases, add a little to the evidence supporting the curative quality of lead in malignant neoplasms. The first criticism that naturally is suggested against estimating the value of lead in this series of cases is the fact that the injections of lead have been combined with the applications of the X-ray and radium. This criticism, however, is less valid amongst those who are experienced with the use of these agents alone. In Case I, mammary cancer with extensive bone lesions, in which the lead injections were not begun until two months after the X-ray had apparently failed to check the progress of the disease, the favorable effects observed after the lead injections may be ascribed to the late effects of the X-ray, which our experience has shown us does occur. But we have never seen such marked and prompt effects in these lesions before. In Case II, marked regressive changes were observed before the radiation was begun. In general, however, our observations indicate that the combined treatments accounted for the effects, and the observations are too few to estimate how much was due to the lead and how much to the radiation. We know, however, that with the exception of the case with the Ewing tumor, all of the tumors are radio-resistant, requiring large amounts of radiation skilfully applied to produce even partial regressions. It seems fair, therefore, to ascribe a considerable part of the changes to the lead. In the case of the Ewing tumor, we know that radio-sensitiveness is one of its features and we almost invariably observe prompt and apparently complete primary regressions after suitable radiation. But the failures to respond with such tumors occur frequently under the conditions that existed in this case—a rapidly growing and altered tumor immediately following an operation. It is rare also to observe such a complete and rapid regression with so much restoration of bone and function. Time, however, in this case must decide the real effects because by radiation alone recurrences or metastases have always finally occurred.

Regarding the theories of Blair Bell and others as to how the lead produces its effects either alone or in combination with the X-ray and radium, our observations do not allow us to make any dogmatic statements. The failure, however, of the lead, either alone, or in connection with radiation, to produce any favorable changes in the case of a malignant chorio-epithelioma of the vagina, which is secondary to a primary tumor of the uterus, does not tend to confirm Blair Bell's theory of selective action of lead upon trophoblastic cells. The idea of Clark that the metallic colloids act as do non-specific proteins, merits, we think, some consideration. Our observations of the changes in the bone tumors we have treated by a combination of lead and radiation tend to confirm the work of Aub, Fairhall, Minot, and Reznikoff, who found that the skeleton is the only tissue to retain any significant amount of lead. It also appears to suggest the accuracy of the conclusion of Martland



## LEAD TREATMENT OF MALIGNANT NEOPLASMS

and others that the lead is stored in the bone-marrow as a part of the reticulo-endothelial system. Hothusen, in an elaborate monograph, reviews all of the literature relating to the various methods of increasing the radio-sensitiveness of tumors and concludes that little from a therapeutic standpoint has resulted. There were too many variable factors, he thinks, to make an estimate of the value of the different experiments. Regarding the efforts to increase the secondary radiations by the use of colloidal metals, he naïvely says that it is impossible to judge clinically because these colloids themselves may have a restraining power over the growth of neoplastic cells. It may be, therefore, that the effects upon tumors that have so far been observed by this method of therapy will reopen the field of chemotherapy and lead to some other and more effective substance.

### CONCLUSIONS

I. It does not appear to us that the intravenous injection of lead offers a cure for malignant neoplasms.

II. Our experience suggests that in cancer of the breast, especially in the bone metastases from this tumor, the lead alone can produce favorable changes, and, if used in connection with radium or the X-ray, can cause, regression sufficiently complete in advanced cases to make greater palliation in radio-resistant tumors than has hitherto been accomplished.

III. In malignant osteogenic sarcoma, our experience strongly suggests that lead in conjunction with radiation offers a valuable method of treating such tumors.

IV. We have no theory to offer as to how the lead produces changes in tumor tissues, but our failure to observe any favorable change in a case of malignant chorio-epithelioma does not tend to confirm Blair Bell's theory of its selective action upon trophoblastic cells.

V. We are unable to make an accurate comparison of our clinical results with those of Blair Bell, but they have been produced with less amounts of lead and, apparently with less constitutional damage.

VI. Changes have been observed in tumors after one injection of 80 milligrams.

VII. We have not made our injections at definite intervals, always awaiting a satisfactory recovery of the patient from the previous injection before giving another.

VIII. With our preparation of sol it has been unnecessary to use gelatin or other protective agent.

IX. Expressed in terms of milligrams of colloidal lead, we do not advise a single dose of over 90 milligrams in any case, and are inclined to think that 75 milligrams will be a safer amount and will produce the same clinical effects upon the tumors. For patients weighing less than 100 pounds, we think that a dose of approximately 1.5 to 2 milligrams per kilo of body weight will offer a fair guide.

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# MULTIPLE GIANT-CELL TUMORS\*

REPORT OF A CASE AND REVIEW OF THE LITERATURE

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GIANT-CELL tumors have held a very prominent place in American studies and discussions of bone pathology since Bloodgood, in 1910, called attention to the benign character of this condition and in 1912 recommended the name which now is in common use. Single giant-cell tumors are not uncommon. The literature contains reports of several hundred cases and there are undoubtedly many more that have not been reported. Multiple giant-cell tumors, however, are sufficiently rare to warrant our reporting this case with a résumé of the previous cases which we have found in American and foreign literature.

**CASE.**—J. M., age twenty-two years, well developed, well nourished, but rather anæmic white male, was admitted to the Episcopal Hospital, service of Doctor Alexander, on October 20, 1926, with a fracture of both femurs in the middle third and the right humerus at the junction of the upper and middle third.

**Family History.**—Father, mother, four brothers and one sister living and well. Grandmother died of cancer. Family history otherwise negative.

**Personal History.**—Measles, chickenpox and tonsillitis in childhood. Operation for varicocele at the age of fourteen years. Operation for a ruptured right ligamentum patellæ, January, 1925 (X-rays of the right knee taken at that time showed beginning bone changes). Injury to the right arm two weeks before admission showed no fracture in X-ray but a pathological bone condition suggestive of chronic cystic osteitis of the shaft of the right lower humerus and ulna. Punched-out areas were seen in the lower end of the humerus and periosteal proliferation along the border of the ulna, which in certain places had a lacework appearance.

The patient's habits are good. He has considered himself in good health but gives a history of rheumatism in the knees for the past four months, with sharp deep pains in the legs, which were worse in bad weather. He has lost twenty pounds of weight in the last five weeks. No history of venereal infection.

**Present Illness.**—Patient slipped and fell in the bath tub and broke both femurs and the right humerus. He was brought immediately to the hospital. Buck's extension and Volkmann's sliding splints were applied to both legs and the right arm was dressed with a shoulder cap and right-angle splint. This was changed after several days to a weight extension dressing.

**Physical Examination.**—Patient is a well-nourished white male, about five feet ten inches in height and weighing about 180 pounds, appearing rather anæmic.

**Head.**—Is negative except that the teeth are in poor condition and pyorrhœa is present. There is a hoarseness of the voice which was later found to be due to paralysis of the left true vocal cord, which had come on following an anæsthetic eighteen months

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\* Read before the Philadelphia Academy of Surgery, April 4, 1927.

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previously. There is a small tumorous swelling in the right mandible near its angle, the result of an injury while boxing.

*Chest.*—Heart and lungs are negative. No nodules are found on the ribs.

*Abdomen.*—Negative.

*Extremities.*—Show fractures of both femurs and the right humerus, with displacement, pain; swelling and crepitus. There is a scar over the right knee from previous operation. There is swelling of the lower end of the left radius.

*Progress Notes.*—October 20, 1926: X-ray examination. Besides the fractures all bones were involved in a pathological condition and was interpreted as follows:

"There is a generalized fibro-cystic osteitis with an atypical appearance in different regions, which in the distal end of the radius and the lower extremity of the left femur has advanced to that of a giant-cell tumor. In the region of the elbows, it has the appearance of a chronic osteomyelitis. In the right femur the appearance suggests strongly the possibility that the process has undergone a sarcomatous degeneration.

November 8, 1926.—Biopsy of the tumor of the left radius. Pre-operative diagnosis, giant-cell tumor. Under nitrous oxide and oxygen anæsthesia an incision four cm. long was made on the dorsal aspect, over the tumor, of the lower end of the left radius. Cultures were made from the skin, subcutaneous tissues, fascia, periosteum and medullary cavity. When the periosteum had been shoved aside with a small separator a piece of bone sufficient for study was quite easily removed. It was shell-like about one mm. in thickness and the curette easily broke through into the medullary cavity. The contents of the cavity was a soft, red, bloody spleen-like pulp. Some of this material was also taken for study. There was a slight bloody ooze, but the incision was closed completely with interrupted silkworm gut suture. The wound healed by first intention within ten days. Pathological report of biopsy was giant-cell tumor, and the cultures taken were negative for organisms.



FIG. 1.—High power view of the tissue taken from the lower end of the left radius.

November 23, 1926.—X-ray of the lower end of both tibias and fibulas and of the bones of the feet and ankles showed the same moth-eaten areas as elsewhere. The pelvis showed mottling and there was a pathological fracture of the femur of the left leg, not discovered clinically. X-ray of the chest showed the lungs not infiltrated with metastatic neoplasm, but the eleventh left rib showed a tumor at its angle.

December 9, 1926.—Biopsy of the left ulna. Pre-operative diagnosis—chronic osteomyelitis; incision was made over the upper part of the ulna so that the bone was exposed about five cm. below the tip of the olecranon. Cultures from the skin, fascia, periosteum and bone were taken. The bone was found to be roughened and not as hard and compact as normal bone. No medullary substance was exposed. A small piece of bone was removed and the incision closed. The wound healed by first intention. Pathological report was giant-cell tumor and the cultures were sterile.

Biopsy of the tumor at the lower end of the right femur revealed a condition similar to that of the left radius. The bone tissue was shell-like, one or two mm. thick, and the marrow a spleen-like pulp; there was a great deal of hemorrhage. Bone and marrow tissue were removed for study and cultures were taken as in previous operation. A rubber tissue drain was inserted and the incision closed with interrupted sutures. The

wound healed by first intention except at the site of the drain and this healed by rapid granulation. Pre-operative diagnosis was sarcoma. Laboratory diagnosis was giant-cell tumor and again the cultures showed no growth.

*December 13, 1926.*—Areas of right radius, left ulna and right femur, from which biopsies were taken, have a more extensive moth-eaten appearance, as shown by X-ray.

*December 31, 1926.*—Clinically there is only fibrous union of the fractures. All weight extensions have been removed (seventy-two days after admission).

*January 28, 1927.*—By X-ray the fracture of the right humerus showed excellent callous formation (100 days after fracture). "There should be some bony union. There also seems to be some calcium deposition within the bone. There is practically no change in appearance of the left forearm. There is slight callous formation about the fracture of the left femur, but very little if any calcium deposition."

*January 31, 1927.*—Patient is up in a wheel chair. He can use his right arm to feed himself. He has a good appetite and is clinically improved. There is a false joint at the site of fracture. There is non-union and non-use of the femurs.

*Laboratory Data.*—Urine negative for Bence-Jones albumin on three occasions, a trace of albumin with an occasional granular cast. Blood nitrogen and blood sugar normal. Icterus index 11.2. Van den Berg negative. Hæmoglobin 50 per cent. Red blood-cells 2,830,000. White blood-cells 20,600. Polymorphonuclears 92 per cent. Transitionals 1. Lymphocytes



FIG. 2.—Section from the giant-cell tumor at distal end of left radius.

15 per cent. Eosinophiles 2 per cent. Anisocytosis and Poikilocytosis present. Blood calcium 15.4 mgm. per 100 c.c. Blood phosphorus 2.1 mgm. per 100 c.c. Spinal and blood Wassermann negative. Spinal colloidal gold negative. Spinal fluid cells 2 per cu. mm.

#### CASES IN AMERICAN LITERATURE

**CASE I.**—CRILE AND HALL.—A young unmarried woman, aged twenty-two years; X-ray pictures of the skeleton showed numerous bones involved in a pathologic process; operation was performed on a lesion in the right tibia; gross and microscopic study was made of the contents and a diagnosis of multiple giant-cell tumor was made. The etiologic factor was not ascertained. The history states that the patient's mother had syphilis and her father diabetes. The patient had no evidence of acquired lues and also failed to improve on anti-luetic treatment. However, it was noted that the exploratory wound gave no evidence of healing until the patient was put on iodide therapy. Prompt healing of the wound then resulted. Ten years later (1915) when the case was seen by Doctor Hirsch in the Bellevue Hospital, there were numerous masses, apparently attached to all the bones. X-ray revealed multiple multilocular cystic tumors which were diagnosed multiple giant-cell tumors.

**CASE II.**—HARTUNG AND KANAVAL.—Male, thirty-four years, a carpenter, admitted to the hospital with an ununited fracture of the left femur sustained six months previously. Patient walked with a cane and crutch. A diagnosis of bone cyst was made. Four years later he had involvement of both clavicles, several ribs, right ulna, tibia and fibula, right humerus and femur, left tibia and one metatarsal, and an old fracture of the left hip. Three years later the case was presented to the Chicago Surgical

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Society. Several cysts had been scraped out and revealed a pathological picture of giant-cell tumor.

CASE III.—HAUSSLING AND MARTLAND.—A married woman, twenty-five years old, has had four normal deliveries and one miscarriage in which there was much hemorrhage and following which she had weakness, dyspnoea, palpitation on exertion. She fell and broke a femur six inches above the knee in October, 1914. There was union without deformity. May, 1915, she had a full-term labor. In June, 1915, she was admitted to the hospital because of weakness and dyspnoea. Examination of the heart showed a loud systolic murmur and the lungs with signs of early tuberculosis in the left upper lobe. Palpable tumors were found in the right orbit, both clavicles, left tibia, and seventh right rib, and further, by X-ray, in the right femur, right and left fibulas, right humerus and in the pelvis. Biopsy of the growth on the left tibia showed a characteristic giant-cell tumor. Curettage of several tumors was later done. Incisions united by primary union. The tumors recurred and later others were also found elsewhere.

CASE IV.—BARRIE.—White male, aged fifty years, married, youngest child eighteen years old. Wife had no miscarriages. Denies venereal infection. Had sciatic rheumatism fifteen years previously, attacks of weakness of legs and feet eight years ago, and again seven years ago. All teeth extracted six years previously. Diagnosed amyotrophic lateral sclerosis five years ago. While on his way to the hospital for this admission he had an accident and fractured the eighth, ninth and tenth ribs. X-ray showed areas of osteolysis in the long bones of the lower extremities, the ribs on the right side, the fractures being through the pathological areas. There was a mass on the right tibia the size of a hen's egg. Diagnosis of multiple gumma was made, and treatment given without result. Exploratory operation of the tumor on the left tibia revealed giant-cell tumor.

### CASES IN FOREIGN LITERATURE

CASE I.—HIRSCHSPRUNG.—Female, thirty-five years old, fell and fractured the left hip. Had union with shortening. Also had a periosteal swelling of the left shin bone. Four years later she was admitted and treated for rheumatism and periostitis, and died of marasmus. Post-mortem showed no changes in internal organs. Left humerus had a healed fracture at the anatomical neck, the left tibia a healed fracture in its middle, and the left femur a healed fracture at its neck. The bones at the site of fractures were soft and cystic and in the tibia at the site of fracture was a small giant-cell sarcoma.

CASE II.—SCHOENENBERGER.—Female, thirty-three years of age, no previous illnesses. During her third pregnancy developed pain in the back and limbs, which persisted after labor and was treated as a chronic articular rheumatism. She was admitted to the hospital because of this pain, and acute joint pain followed by swelling of the bones. She had multiple fractures due to slight trauma. Autopsy later showed fracture of the right and left humerus, right and left femurs, lordosis of the lower thoracic vertebræ, fracture of numerous ribs, cyst-like tumors of the left tibia and right tibia and fibula and humerus, both femurs, pelvis, etc., which proved microscopically to be giant-cell sarcoma.

CASE III.—SCHLANGE.—Male, eighteen years of age, had a fracture in the middle of the femur five years previously. After healing there was pain and deformity of the leg. Operation revealed a cyst three cm. long with serous fluid, and a second cyst the size of a walnut, extending into the greater trochanter. Microscopic examination showed the bases of the tumor masses to be cellular connective tissue with delicate bone formation, and in the region of the area of softening numerous giant-cells.

CASE IV.—REHN.—Female, twenty-three years of age; admitted because of pain in the right hip with visible swelling. Discharged after two and one-half months slightly improved. Re-admitted ten months after onset with pain and a rapidly growing tumor at the distal end of the right ulnar. It was removed at operation. Examination revealed

a gray, red, friable mass and microscopically giant-cell sarcoma. Two months later the shaft of the right femur, right ileum and right humerus were affected. Biopsy of the right ileum tumor revealed a giant-cell sarcoma. Several months later the right lower leg, eighth and ninth ribs, left sacro-iliac joint, and left tibia were all involved. Operation on the sacro-iliac joint because of pain showed giant-cell sarcoma also. One year later tumors had increased in size and number and there was a spontaneous fracture of both femurs, which healed. There was progressive deformity due to fractures and softening of the bones. Patient died four years later of anasarca.

CASE V.—HABERER.—Boy, ten years of age, well until three years ago, and has developed irregular increasing, painless swellings of the right side of the head and face. There was a five-year-old slight traumatic fracture of the right femur in the

middle third which had healed with deformity, and three years later slight trauma had increased the deformity. X-ray showed lesions in the right parietal region, lower jaw, right femur, left trochanter, left coxa vara. Exploratory operation showed that after cutting through the thin cortex multilocular hemorrhagic cavities, filled with soft, red, brown, sarcomatous masses were found. Microscopically, it showed widely disseminated giant-cells and spicules of bone. Diagnosis: Giant-cell sarcoma. Progress was benign.

CASE VI.—HART.—Female, seventy-eight years of age, well until sixty-eight years of age, and lived in an Old Folks' Home, had a spontaneous fracture of the femur while lying in bed. She died of hypostatic pneumonia and suppur-

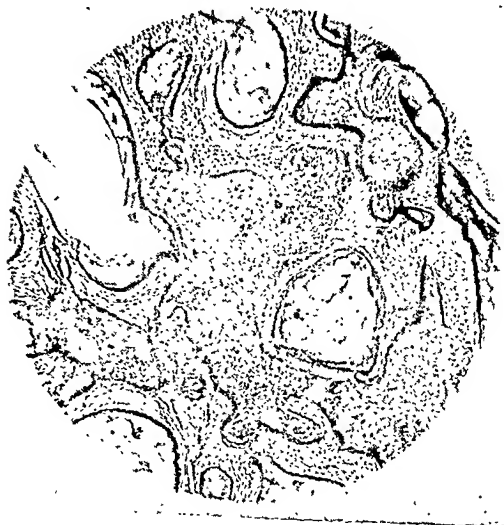


FIG. 3.—Section taken from the crest of the left ulna about five cm. from olecranon.

ating bronchitis. At post-mortem, skeletal tumors were found in both femurs, both tibias, pelvis, ribs, right humerus, elbow, radius, eighth and ninth thoracic vertebra, all due to giant-cell sarcoma and cysts.

CASE VII.—GUENTHER.—Reported a case of Fischer's. Carpenter, age forty-six years, came to autopsy with a diagnosis of osteomalacia. Anatomical diagnosis was multiple tumors, myelomatous and myelosarcomatous, throughout the bony system, with fractures of both femurs, the left humerus, and a tumor of the right parathyroid. Microscopically the bone tumors showed the picture of giant-cell tumor of the epulis type.

He also quotes Schmoil as reporting four cases of osteomalacia with parathyroid changes, and Mollineau's case of osteitis fibrosa with multiple giant-cell sarcoma in which three of the parathyroid bodies showed changes. He also collected two other cases to show the relation between malacia of bone and parathyroid bodies.

#### CASES OF FIBROCYSTIC OSTEITIS WITH ASSOCIATED MULTIPLE GIANT-CELL TUMORS

MORTON (*Archives of Surgery*, 1922, vol. iv, p. 534) has carefully studied and analyzed many cases of fibrocystic osteitis with giant-cell sarcoma from which we briefly quote the following cases:

(a) WERNDORFF.—Male, age nine years, with tumors in the right femur and right tibia, duration from earliest childhood, causing deformity of the right leg. Resection of the tumor of the right femur proved to be giant-cell sarcoma.

(b) BUTLIN.—Male, age fifty years, who since he has been forty-three years old



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has had tumorous masses growing on the jaw and on the sixth right rib. At autopsy these were found to be giant-cell tumors.

(c) Female, age forty years, had tumorous formations on the upper and lower jaw, duration ten years, causing swelling, and when removed and studied were found to be giant-cell tumors.

(d) DAVIDSOHN.—Male, fifty-eight years old, with tumors of the tibia, patella and femurs, discovered five years previously. Came to autopsy and showed giant-cell tumors.

(e) GAUGELE.—Female, age thirty-six years, who had shown symptoms since twenty-eight years old, the tibia, humerus and ulna being involved. The symptoms were fractures, swellings, deformity, anæmia and emaciation. Pathological report indicated giant-cell sarcoma.

(f) VON RECKLINGHAUSEN, 1891, CASE VII.—Female, age forty years, with tumors of the left ileum, upper and lower jaws, radius, tibia, ribs, fibula and femur, and who had been treated for pain, fractures and deformity, died of marasmus. The pathological report included giant-cell sarcoma.

(g) LOTSCH.—Reported a case, age fifty-seven years, who dated the onset of his condition ten years previously, who showed tumors of both tibias. Exploratory operation was done which showed giant-cell tumors.

(h) MONCKEBERG.—Female, aged fifty-five years, who since thirty-nine years of age has had a tumor of the jaw and another tumor of the ninth rib. The tumor of the jaw was extirpated three



FIG. 4.—Section taken from right femur at biopsy, December 9, 1926.

times and it showed a giant-cell tumor.

### CASES SUBMITTED TO THE SARCOMA REGISTRY

From a recent communication from Dr. B. C. Crowell, we add the following cases which have been submitted to but not definitely decided upon by the Committee on Bone Sarcoma:

CASE 70.—Dr. R. E. FORT, Nashville, Tenn. Date of onset about November 12, 1912. A boy of eleven with a tumor of the first rib. July 23, 1913, excision of first rib, clavicle and part of sternum. Post-operative Coley toxins. Registrar's classification—Giant-cell tumor. Late note, May, 1923—well. Published in *Surgery, Gyn., and Obst.*, June, 1914, pp. 696-698. September, 1924—well. May 1, 1925—well.

CASE 110.—Dr. J. C. BLOODGOOD, Baltimore, Md. Date of onset about 1917. A man of twenty-seven with a tumor of the upper end of the tibia and femur. July, 1920, exploratory incision by family doctor. Sinuses followed. November 27, 1920, amputation of femur by Doctor Carr. Registrar's classification—giant-cell tumor. Last note March, 1921—well.

NOTE.—A recent communication from Doctor Bloodgood states that he has three cases of multiple giant-cell tumors which he has not published.

CASE 167.—Dr. JAMES EWING, New York, N. Y. Date of onset January, 1918. A boy of ten with a large tumor of the pubis, ischium and acetabulum. Pathologic fracture. Very clearly a giant-cell tumor from X-ray. No incision. Treatment: Fixation and radium. Registrar's classification—giant-cell tumor (X-ray diagnosis only). Last note, June, 1923—well, good function. July 12, 1924, no change. July 9, 1925—well. October, 1926, no further report.

CASE 212.—Dr. DAVID CHEEVER, for the Peter Brent Brigham Hospital Clinic.

Date of onset April, 1920. A man of twenty-four with a tumor of the lower end of the left tibia and the fibula. Previous operations, about July, 1920, diagnosis was made of giant-cell sarcoma; recurrence and second operation March, 1921, followed by radium and X-ray treatments. Incision has never healed, continued lameness and soreness, although patient was able to work. Admitted to Peter Brent Brigham Hospital, April 20, 1922.



FIG. 5.—Left radius and ulna showing a giant-cell tumor.

Examination showed nearly complete destruction of lower end of tibia, marked involvement of fibula and invasion of ankle-joint. Patient developed a severe pyogenic infection from the unhealed wound from which tumor tissue was sprouting and had to have multiple incisions of leg and thigh. Amputation of the lower leg was done July 13, 1922. Patient discharged with stump well healed on July 28, 1922. X-ray of rest of skeleton and lungs negative. Pathological examination—giant-cell tumor. Registrar's

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classification—giant-cell tumor. Last note, April 7, 1924, well, wearing artificial leg. July 23, 1926, no further report.

CASE 590.—DR. G. E. PFAHLER, Philadelphia, Pa. Date of onset, 1919. A man forty-two with a large tumor involving upper end of the femur, pubes, acetabulum and ischium. Case diagnosed as osteo-sarcoma at Samaritan Hospital, May, 1922. October 9, 1922, admitted to Medico-Chi Hospital. Pain first noticed in the knee three years before admission and a little later pain in the left hip. Eleven months before admission noticed a lump in the left groin. On admission, leg flexed and unable to step on foot. Treated by X-ray from October 9, 1922, to October 16, 1923. Marked improvement, and in two months was able to leave the hospital.

Registrar's classification—Benign giant-cell tumor. Last note, October, 1924, has been using the leg and working for the past year and a half. To have further radiation because of arrest of calcification in tumor. February 10, 1925, further X-ray studies showed that the head of the femur is destroyed. Having increased pain. No increase in calcification. Hip-joint ankylosed.

### DISCUSSION

Giant-cell tumor, giant-cell sarcoma, hemorrhagic osseous dystrophia, myeloid sarcoma, myeloma, osteitis fibrosa with giant-cells, chronic hemorrhagic osteomyelitis and "brown tumors" are all terms used with reference to a similar bone condition. The subject was much studied between 1840 and 1860. Lebert, in 1845, was probably the first to recognize the condition. It was later described by Paget in 1854, and later by Nélaton in 1860 in an elaborate monograph.

Nélaton emphasized the proliferation of giant-cells, myeloplacques, as the essential factor in the process. He insisted that the giant-cells must predominate in the tissue and not be present merely in small numbers, since such cells were occasionally seen in other tumors. He recognized several other anatomic varieties, depending on location, conformation, structure and stage of evolution of the tumor. The age of incidence was mainly between fifteen and




FIG. 6.—Left ulna showing the area from which biopsy was taken.

twenty-five years. Without the aid of the microscope diagnosis was usually impossible. Regarding prognosis, Nélaton was quite specific, saying that every tumor composed essentially of giant-cells should be regarded as benign. He also advocated cauterization with zinc chloride following curettage, since the tumor would generally recur if any fragment was left.

Virchow (1864) is often quoted as emphasizing the malignant behavior

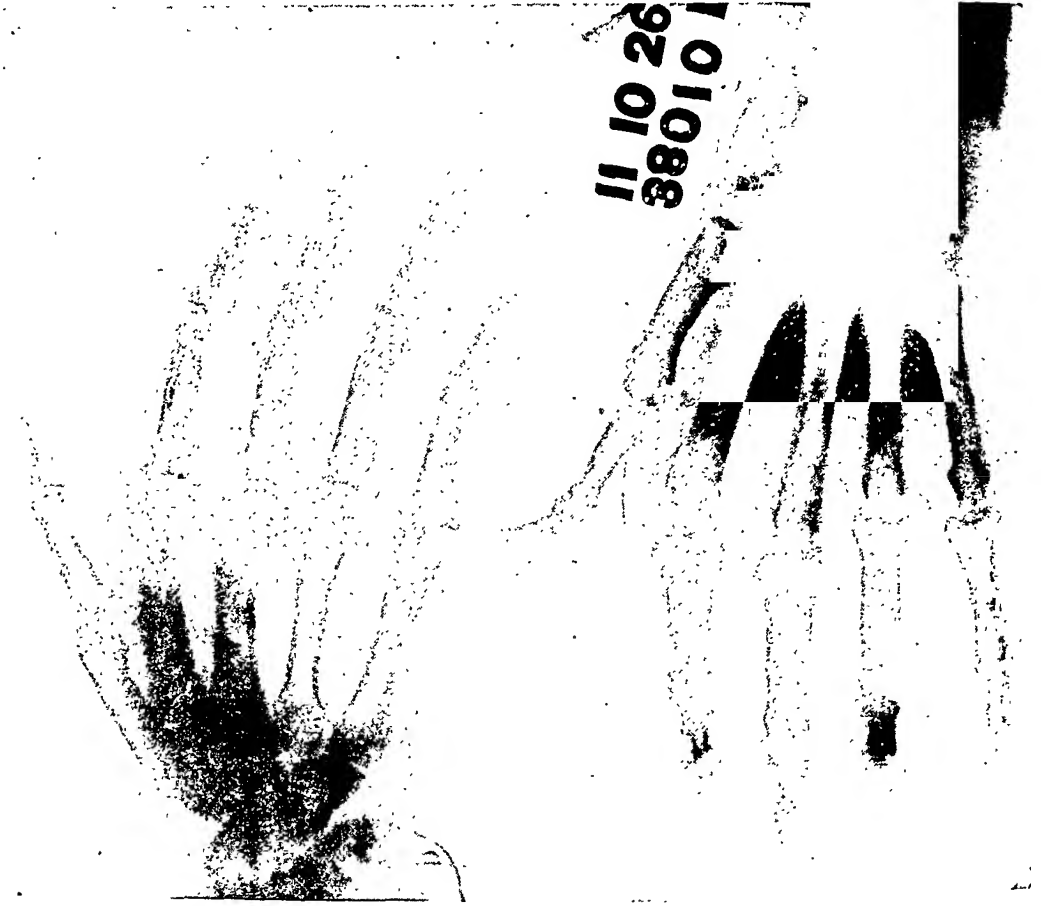


FIG. 7.—Both hands: showing a giant-cell tumor of the distal end of third metacarpal, right hand, and showing also the typical moth-eaten appearance of bones of the hands.

of certain myeloid sarcomas, but was unable to demonstrate that any of his malignant cases had not been such from the beginning.

Gross, in 1879, described in detail the features of giant-cell sarcoma, analyzing seventy cases from various sources and emphasizing their benign character.

In America, the facts established regarding giant-cell tumors seem to have been largely disregarded for many years and most of the tumors were subject to radical operation, until Bloodgood, in 1910, called attention to the benign character of the disease.

Giant-cell tumor is a specific tumor, believed to take origin from the fibrous tissue framework of the bone, whether periosteum or endosteum, and characterized by the invariable presence of osteoclast-like giant-cells in large numbers. It has at various times been considered the result of bone destruc-

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tion due to spirochæte, tuberculosis, infectious bacteria and parasites, trauma, malnutrition and metabolic change. While it must be recognized that the solitary local process and the multiple systemic lesions give exactly similar gross and microscopic pathologic findings, it is also quite clear that the etiologic factors bringing about these apparently identical conditions are varied. In most cases the cause of solitary lesions is trauma. Von Recklinghausen regarded the systemic multiple lesions as different forms of *malacia*. Guenther, more recently, believes it is due to a lack in the balance of bone chemistry associated with parathyroid disturbance.

Giant-cell tumor classification has created much discussion. One school considers it neoplastic and another inflammatory, while a third states that it is a border-line lesion between these two. It is generally considered, however, as resulting from some chronic irritation, which may follow a metabolic disorder. The lack of calcium deposition weakens the bony structure; local injury, the stress and strain of motion and work, organisms etc., are all irritants.

The inflammatory proliferation of tissue is then essentially a regenerative process which has for its aim the compensation of the lesion produced by the cause of inflammation. Under special conditions this leads to a hyperplastic proliferation of connective tissue, frustrates its own aim and causes new damage. This is particularly the case when, as a result of the inflammation in the organism, there is kept up a permanent condition of inflammation. The bone tissue thus replaced by cellular tissue, softens and produces multiple

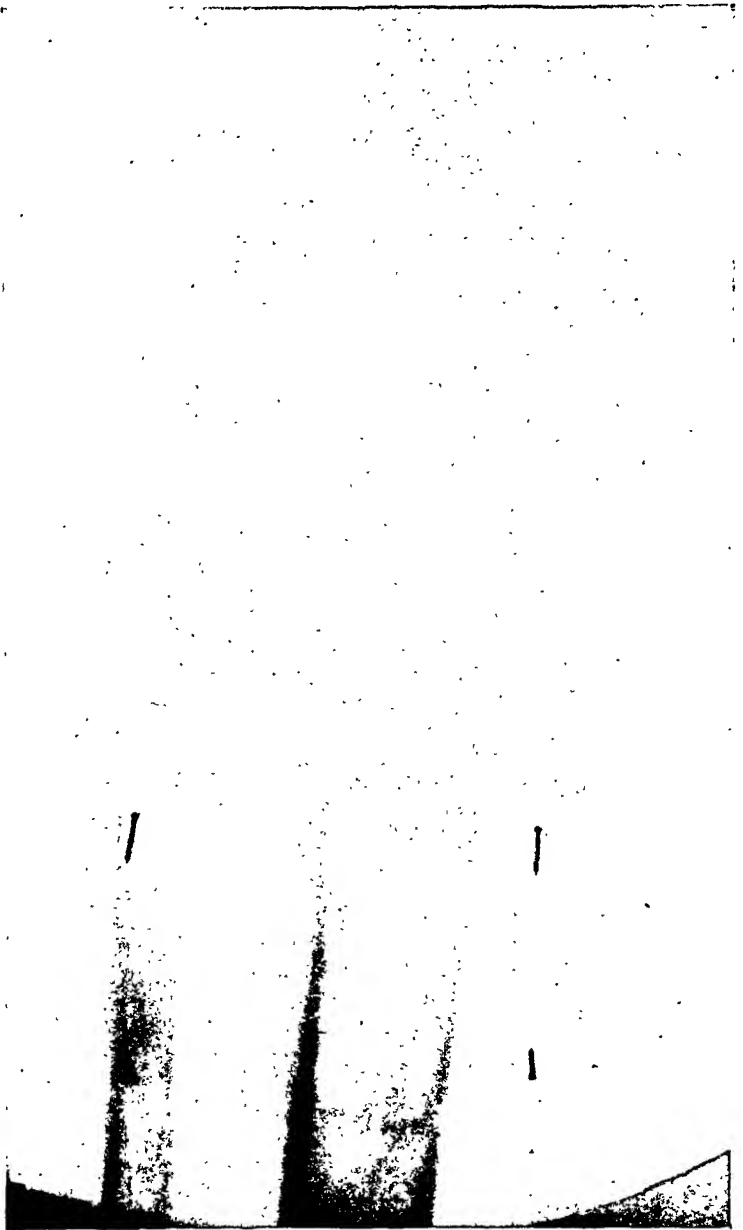


FIG. 8.—Right knee showing evidence of a giant-cell tumor at upper end of the tibia

bone cysts lined with fibrous tissue and filled with clear fluid, fibro-cystic osteitis, or within the fibrous tissue lining the giant-cell tumor develops.

The giant-cell tumor usually arises in the interior of the shaft of long bones near the epiphyses. It is of slow growth, does not produce metastasis or cachexia, expands the bone abruptly, and in the X-ray appears trabeculated. The bone may be so thin as to crackle, and when cut is quite soft, vascular and resembles splenic tissue, but having a firmer opaque texture on the surface and central softer, cystic, or hemorrhagic areas. There is seldom any tendency toward invasion of the soft parts. Microscopically the framework has much the appearance of granulation tissue with hemorrhagic areas and abundance of large giant-cells containing many small oval nuclei.

According to Mallory, there are two types of giant-cells, a tumor giant-cell and a foreign body giant-cell. The former are large, clear, bladder-like cells, with distinct outline but staining faintly, within which are multiple nuclei, or a large multilobulated nucleus with mitotic figures, which stain deeply and are situated in the centre of the cell. They are usually not important features of the microscopic picture, but may be numerous and conspicuous. They are true tumor cells resulting from multiple mitosis and signify rapid growth. The second type are as a rule smaller, their cytoplasm fairly abundant, sharply defined and staining deeply with acid dyes. The nuclei are smaller, uniform, more numerous, without mitosis, and are often in clusters near the periphery of the cell. They resemble osteoclasts and are merely a reaction to the presence of foreign bodies and are due to the fusion of endothelial leucocytes.

Von Hansmann has classified giant-cells briefly as follows:

1. Foreign body giant-cells of endothelial or leucocytic origin.
2. Parenchymatous giant-cells, tumor-cells proper, due to irregular mitosis and lack of cell division.
3. Myelopaxes, present normally in red bone-marrow and characteristic constituents of myelomata.

The giant-cells of our own giant-cell tumor would be in Mallory's class two, and Von Hansmann's class one.

Giant-cell tumors may be present an indefinite time without giving rise to any symptoms. Often the first indication of their presence is the occurrence of pathologic fractures. In our case, after reviewing the films, X-ray shows beginning bone changes eighteen months before the patient was brought to the hospital with symptoms; also, we have done biopsy on areas absolutely symptom-free and found early giant-cell tumor formation. However, according to the location of the tumors, they may cause pain due to expansion and pressure on the soft parts.

Diagnosis is made by biopsy and microscopic examination, or may in a few cases be made by röntgenogram.

The treatment of single or multiple giant-cell tumors, when few in number; consists of thorough curettage and the application of pure carbolic acid, followed by the use of alcohol, or perhaps, better still, 20 per cent. zinc

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chloride. The cavity is then kept clean with Dakin's solution until healed. Coley, in 1924, advocated the additional use of mixed toxins of erysipelas and bacillus prodigiosus, given systematically for a period of three or four months, and if available, one massive dose of radium, made over the tumor after the danger of infection is over or when the sinus has entirely healed. X-ray treatment is said to give great benefit, if not a cure.

### CONCLUSIONS

1. Giant-cell tumors, especially multiple tumors, are being found more prevalent than previously, due to the X-ray.

2. No cases of multiple giant-cell tumors have been accepted as true entities by the Committee on Bone Sarcoma. (Doctor Codman, in a recent communication, states that he is skeptical about the existence of the condition.)

3. We report this case without knowing what previous pathologic condition existed at the areas biopsied, nor what change may take place in the course of a few years, should the patient live, but we have selected areas which should show different stages and we have found them to be multiple giant-cell tumors.

4. We have attempted to collect the cases from the literature in which multiple giant-cell tumors were believed to exist either alone or in conjunction with other bone changes.

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# THE PRINCIPLES UNDERLYING THE SURGERY OF CARCINOMA OF THE RECTUM\*

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THERE is no major operation of surgery concerning which there still exists such a divergence of opinion and method as in carcinoma of the rectum. This year (1927) we begin the second century of the development of the subject for it was in 1826 that Lisfranc first performed the operations which entitle him to rank as the father of major surgery of the rectum. It is true that Paget in 1739 first amputated the rectum for cancer, but his attempt, disappointing in its result, led to no development. Lisfranc's operation, still known by his name, consisted in liberation of the lower segment of the rectum through elliptical incisions encircling the anus, the bowel being amputated above the tumor. The progress of the operation for many years consisted chiefly in efforts to increase the exposure and enlarge the limits of excision. Lisfranc himself in later cases split the mobilized rectum in order to determine the upper limits of the growth. Denonvilliers added an incision posterior to the anus reaching to the tip of the coccyx. Verneuil and Kocher excised the coccyx and gained room for resection and anastomosis in suitable cases, thus preserving the sphincter function. Dieffenbach made two incisions, one anterior, the other posterior to the rectum in the midline which were deepened to the level of the tumor above which point the bowel was mobilized, excised and its upper segment brought down to the cleft perineum which was repaired to preserve the sphincter. The results of these and other modifications, however, were such that English surgeons stoutly maintained the advantage of colostomy which merely prolonged life and made it more comfortable. The French held to rectotomy and the Germans practiced ablation when the growth was low enough to be accessible. Franks remarked that the indication for operation depended much more on the nationality of the surgeon than upon the condition of the patient.

The great stimulus to more radical surgery came with Kraske's paper in 1885, describing a method of approach by removing the coccyx and a portion of the sacrum. This afforded opportunity for extensive removal of the rectum and perirectal tissues. High lying growths could now be reached and even the lower sigmoid could be mobilized. Kraske held to the advisability of preserving the sphincter when not directly involved by the growth. He practiced anastomosis of the upper segment with the lower, but later finding that the line of suture usually gave way posteriorly, he contented himself with making a partial anastomosis anteriorly, leaving the posterior portion to be closed by a plastic procedure at a later stage. When anastomosis could not be made, a sacral or gluteal anus was made. Kraske's proposals imme-

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\* The Annual Oration in Surgery, before the Philadelphia Academy of Surgery, March 7, 1927.



diately gained many adherents. Various technical modifications followed rapidly, giving names to a confusing multiplicity of operations. To a great extent these operations owed their claim to special name to a modification of the means of approach. Kraske removed a portion of the sacrum along a curved line beginning on the left side at the level of the third foramen and terminating at the left cornu. Hochenegg's resection of the sacrum began at the same point as Kraske's, but crossed the midline, curving downward to end at the right cornu. Bardenheuer sectioned the sacrum transversely at the level of the third foramen. Rose carried his incision in a curved line with convexity above, including the third foramen. As a result of the disturbances of innervation of these high sections, Heinecke and Levy devised plastic sections of the lower sacrum, the fragments being reflected like a hinge and replaced after the operation was concluded. Zuckerkandl and Wolfler incised the soft tissues to left and right, respectively, of the coccyx and sacrum and avoided division of the bone.

Other modifications concerned the treatment of the bowel. Maunsell and Weir devised a method of telescoping the mobilized bowel through the anus and making an anastomosis outside the body, after which the line of suture was again reduced through the anus. Hochenegg perfected his "durchziehungsmethod" in which the superior end of the rectum or lower sigmoid is drawn through the anal canal, the mucosa of which has previously been removed. This obviates the necessity of making an anastomosis by suture, with its frequent complications due to separation of the ends or later stricture at the line of union.

The distinguishing characteristic of the German school lay in its development of the inferior or sacral method of approach and adherence to the principle of conserving the sphincter, providing it be uninvolved and the upper bowel sufficiently mobile to reach the perineum. Failing in this a sacral or gluteal anus would be established. They have therefore avoided a preliminary colostomy except in cases of obstruction. Laparotomy has met with little favor except in those cases where special difficulties existed due to height of growth or fixity or evidence of obstruction.

Let us now consider the results of the classical sacral operations. For this an abundance of material is available, but when analyzed there are few homogeneous series because of the many variations in technic by different operators and by the same operator at different periods. The greatest consistent series is that of Hochenegg, whose early and sustained interest in the problem has resulted in an experience of over 1500 cases, 800 of which were subjected to operation. Mandl's exhaustive analysis of this material contains a wealth of observations on all aspects of the condition. The combined operation has been steadfastly rejected except for a few cases absolutely inoperable from below. In his hands therefore this procedure has had a prohibitive mortality and poor results. The series is all the more useful in assessing the possibilities and results of low excision. There were 508 radical operations, an operability of 66.7 per cent. Four hundred and sixty-one cases were

treated by radical sacral operation, of which 234 were one-stage amputations with sacral anus and 205 resections with reestablishment of continuity. Of the amputations, 33 died (14.1 per cent.). 161 patients were followed. Sixty-seven lived over three years. Mandl calculates the end results on the basis of traced patients which must be corrected to make them comparable to our figures which are based on total numbers, counting untraced patients as dead. This corrected result shows 24.3 per cent. three-year "cures," or deducting primary deaths, 33.3 per cent. Data given is insufficient to calculate five years survivals, but 10 cases died of recurrence between three and five years. Of 205 resections 18 died (8.78 per cent.). One hundred and thirty-eight cases were traced for three years. Fifty-eight were living without recurrence (23.4 per cent.) or, deducting primary deaths, 31 per cent. three-year "cures."

Another great collection of figures is from the Breslau clinic reported by Eichhoff. This comprises 1021 cases, of whom 610 were accepted for treatment and only 326 submitted to radical operation, an operability of 31.9 per cent. Although this clinic has adhered to sacral removal, the series lacks homogeneity in many respects, as it stretches from the year 1879 through the régime of Fischer, Von Mikulicz, and the rest of Küttner's predecessors. A great variety of procedures were employed. Of the 326 radical operations, 79 died as a consequence of operation (24 per cent.). Eighty-seven were alive and well at the end of three years (26.7 per cent.), or excluding primary deaths (35.6 per cent.). These are high figures but the very low operability must be borne in mind. Küttner's "vorlagerungsmethod" which is now in use in this clinic consists in liberating in the usual manner by the sacral approach, the bowel and its surrounding tissue which is allowed to remain *in situ* until the following day when amputation or resection, as the case may demand, is performed. This second stage is simple and usually done without anæsthesia. Küttner has had 44 cases with primary mortality of 22.7 per cent. The end results he claims are superior but as yet no comparable figure can be obtained.

The most recent champion of the perineal approach is Lockhart-Mummery, who is a proselyte from the combined method which he formerly advocated. His chief reason for shifting his position was the mortality of the combined procedure. He has returned to the plan of preliminary colostomy and exploration followed in a week or so by perineal amputation. In 1925, Gabriel reported 143 cases operated upon in St. Mark's Hospital, London, by this method during the period from 1910 to 1924. The operability rate was 44 per cent. The primary mortality 15.4 per cent.

The tabulation of cures is as follows:

	3 year cures	5 year cures
Figures based on total number operated.....	23.5% (20 of 85)	24% (15 of 63)
Figures based on survivals .....	28.5% (20 of 70)	28.0% (15 of 54)

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A large number of statistics of end results of the sacral method are available. Most of them are old and many must be corrected to make them justly comparable. These selected series are representative of the best that the sacral method has to offer.

During the development of the sacral method of attacking rectal growths another trend became apparent. In fact, even before Kraske's report, Koenig excised a high lying growth by the combined method, first opening the abdomen, establishing a colostomy and then amputating the bowel from below. His patient died. The operation was performed in 1882, but the case was not published until 1888 by Hildebrand. Czerny, often credited with the first combined operation, dealt, not with a cancer of the rectum, but with a growth of the sigmoid. He attempted extirpation through the perineum, but finding this impossible he opened the abdomen, resected the growth and made an anastomosis. His patient also died. The case was not published until 1893 and in reality is not entitled to credit as a combined operation for cancer of the rectum.

Gaudier, of Lille, in November, 1895, and Chalot, in December, 1895, carried out combined operations beginning with laparotomy. Both established an abdominal anus and mobilized the pelvic colon in the first stage. Chalot in addition tied the superior hemorrhoidal artery within the abdomen in order to control hemorrhage during the perineal stage. Both operations were completed in one seance and both patients perished. Gaudier's case died on the fifth day, apparently of pneumonia, and Chalot's case, of renal insufficiency. In August, 1896, Gaudier successfully operated by the combined method upon a woman aged thirty-five. She lived eight months and died of recurrence.

The next operative success was that of Boeckel in November, 1896. He began the operation as a Kraske and found it impossible to complete it from below. He therefore opened the abdomen, divided the colon, made an iliac anus, liberated the lower segment and returning to the sacral route, easily completed the removal. To close the defect in the peritoneum he turned the uterus backward and fixed it to the sacrum.

Quénu now made himself the champion of the combined abdomino-perineal type of operation. In October, 1896, he operated successfully upon a woman of fifty years and separated the perineal from the abdominal stage of the operation by an interval of six days. This is the first instance of the two-stage operation which has of late years been extensively employed in various forms. He did much to standardize and popularize the combined operation, and it is generally known by his name. He emphasized the importance of asepsis and good hæmostasis. In order to assure the latter, he advised preliminary ligation of the internal iliac arteries, but this step has now been abandoned in most quarters as unnecessary.

The combined operation became the accepted French method as the sacral procedure was favored in Germany. Kraske in 1900 admitted the utility of preliminary laparotomy in certain cases and a few German surgeons

as Kirschner, Schmieden and Fischer, Hofmeister, Gulecke, Finsterer and a few others have favored the combined operation. The majority led by Hochenegg, Von Eiselsberg, Kulenkampf, Poppert and Clairmont, have stood by the sacral procedure which still remains distinctively the German method. It is true also that a few French surgeons such as Savariaud favor the low approach, but the weight of opinion of such men as Tuffier, Schwartz, Hartmann, Pauchet and Cuneo is for the combined operation with certain exceptions dictated by the age or condition of the patient. In general, therefore, national lines of division still hold in the choice of operation.

England and America have wavered, though tending in general toward the French methods. In England, Miles is the protagonist of the combined method. In America, Blake, Lusk, Tuttle, Jones and Coffey have favored combined excision. Many surgeons both in England and America, however, have continued to practice the sacral operations, particularly those whose work in this field is limited to the occasional case. The Mayo Clinic which formerly practiced both operations with apparent preference for the combined procedure has been strangely silent for a number of years, but from report and personal observations seem to be following the Lockhart-Mummery method at present, which consists of a two-stage operation with exploration and colostomy at the first seance followed in a week or so by perineal excision.

In the presence of such a diversity of opinion and practice, what are we to conclude? First, it is evident that we are not yet oriented and that standardization belongs still to the future. It does not mean, however, that certain principles have not become clear and that the lines of progress have not been forecast. Of what value are statistics? They are of the greatest value in establishing the fact that carcinoma of the rectum is the most amenable to cure of all internal cancers. Many cases are now on record of long survival after removal of undoubted carcinoma. Hochenegg's first case of sacral removal lived thirty-two years and died of intercurrent disease. Blake in 1925 showed two cases alive and well sixteen and seventeen years, respectively, after combined operation. Cripps reported a case surviving over thirty years after an operation which to-day would be considered incomplete. Like instances could be multiplied. No other variety of internal cancer can show comparable figures.

But we are still groping for the best operation.

It is not possible as yet to settle the matter by the statistical method. The reason for this is the complexity of the factors involved. A great cause of erroneous impressions has been the failure to realize fully the extraordinary variability in the degree of malignancy shown by cancer of the rectum. In a considerable percentage the growth proceeds slowly. Permeation is gradual and it has long been a matter of comment that many growths form metastasis late or sometimes never. Among fifty-eight cases dying from cancer of the rectum, Oehler found 34 with no demonstrable internal metastasis. McVay recently restudied this point in 100 cases dead of cancer of the rectum. Fifty-three per cent. showed no involvement of the regional

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glands, 30 per cent. slight involvement and 17 per cent. marked involvement. Age seemed to play no noteworthy rôle in the distribution of these groups. It is of interest that the smaller, deeply ulcerating growths furnished a greater proportion of metastasis than larger growths with a tendency to grow into the lumen. The application of these studies to clinical purposes must be made guardedly since it is evident to anyone familiar with such researches that it would be impossible to avoid overlooking minimal metastatic deposits. Still it is significant and quite different from the state of affairs in cancer in most other areas of the body.

In Hochenegg's series 150 patients were treated by colostomy alone. Seventy-two and five-tenths per cent. of these died within a year, but 10 per cent. were still living after two years and 5 per cent. after three years. One case survived twelve and one-half years. In the Breslau clinic reported by Eichhoff 167 patients were subjected to colostomy for inoperable cancer. Sixty-two per cent. died within the first year, 6 per cent. lived longer than three years and three patients died in the seventh year. Wells reported a case which ran for seventeen years from the first operation, having been operated upon three times for local recurrence during that period.

Even more remarkably, Mandl lists among the survivors of operation without demonstrable recurrence or metastasis for five to fourteen years, ten cases in which the growth was not completely removed according to gross and microscopic evidence. Two of these cases were of the colloid variety of carcinoma which, it is well known, are often sluggish, relatively benign growths. Hochenegg, however, has not been able to establish any histologic criteria of the degree of malignancy in his huge series. MacCarty and Kehrer have studied 102 cases dead of recurrence in an attempt to correlate longevity with type. The factors selected to indicate body resistance and growth energy were lymphocytic infiltration, fibrosis, hyalinization and differentiation. They found that where all these factors were present in a growth the average survival was three times as long as when none of the factors was present. In general, however, the study bears out Hochenegg's experience that no histological variety can be regarded as universally benign or malignant but cures and failures are well distributed in all groups.

Lockhart-Mummery has recently laid stress on age as an index of the degree of malignancy. It has long been known that in general, cancer in the young is more rapid in its development and fatal outcome than in advanced years. Phifer, in a collected series established the truth of this idea. Lockhart-Mummery states that he has no record of any patient under thirty years of age treated for cancer of the rectum who has not died from prompt recurrence, no matter how drastic the operation or other treatment had been. He doubts whether it is worth operating on such cases. While admitting the force of this contention, it is worth noting that in the Breslau series of 1021 cases there were forty-five cases under thirty years of whom only thirteen were operable. Two can be considered cures, having survived fifteen and twenty-seven years, respectively. Hochenegg also had an experience

of thirty cases under thirty years and on the basis of several permanent cures advises against absolute pessimism. The great majority of the cases fortunately are in the fourth, fifth, and sixth decades. The youngest patient was reported by Rowntree, aged ten years. Bernouille's was eleven. There are several of twelve years and the age incidence slowly increases up to forty, when it abruptly rises, falling again promptly around seventy.

Sex has no apparent influence on degree of malignancy. Men are subject to this disease more often than women, almost in the ratio of two to one. Pregnancy does not appear to heighten the virulence of the condition. Indeed, Hochenegg's experience has been more favorable in cases discovered during pregnancy. The duration of the growth and its character when first observed may give some indication of its malignancy. Miles came to the conclusion that by the time three-fourths of the circumference of the rectum had been involved, the growth was more than a year old and that penetration of the wall of the bowel occurred before one-half of its circumference was involved. This, like all general statements, is subject to many exceptions. Mention has already been made of the fact that the size of the growth bears no necessary relation to the existence of metastasis outside of the bowel. In fact, the relation is more likely to be inverse. Seeing these patients as we do now, only after well-marked symptoms have been present for some months, a large growth protruding into the lumen is of better prognostic import than a small excavated growth which is more often accompanied by glandular or hepatic metastasis. Perirectal infiltration and fixation of the growth is also not a certain sign of the extent of cancerous infiltration as has been noted by many authors since these conditions may be a result of inflammation secondary to ulceration and infection. Following colostomy and relief of infection, the mass itself may shrink and become movable and favorable for removal.

In the presence of these variables one may well shrink from dogmatism not only in the individual case, but in generalities. Were it possible to obtain criteria of malignancy the immense significance would be apparent in prognosis, the evaluation of reported cures and in the selection of suitable operation. In the absence of such criteria we must recognize this great variability in assessing the results of operation. Such knowledge will serve to minimize the value of isolated instances of survival. I have in mind a personal observation of a woman still living twenty years after a simple Lisfranc operation for a very early cancer of the anal canal, of another case alive and well five years after cauterization of a huge inoperable mass involving the ampulla. Such cases and small series for this reason have little bearing on the problem of the best operation for the greatest number.

It would be logical to suppose that the ideal plan of operation in cancer of the rectum would be the same as that which has yielded the most satisfactory results in the surgery of other varieties of cancer, namely, the widest possible bloc excision of tissue in immediate relation to the growth together with the tissue carrying the regional lymphatic vessels and glands. This ideal of inclusion of the efferent lymphatics has given rise to much research, to

various conclusions and to sharp differences as to the appropriate operation to be employed. The investigations of Mascagni, Sappey, Quénu, Gerota, Boulay, Cuneo and Marcille are well known. Miles in his excellent studies has well summarized the previous work on the lymphatics. He divides them into intramural and extramural systems. The intramural lymphatics are those of the rectal walls and are divided into two chief plexuses, one in the submucous tissue and the other between the two muscular coats. These communicate by short radiating vessels with each other and with the peripheral lymph sinus situated between the rectal wall and the perirectal fat. According to Miles the longitudinal spread in the wall is of very limited extent. Handley, however, maintained that special methods showed in certain cases deposits of cancer cells in the wall of the bowel as far as five inches distant from the growth. His results have been much criticized, but recently Winkler has demonstrated that certain cases undoubtedly do show extensions in the submucosa for a distance of four to six inches and that their extension while usually upward may be in the reverse direction. Sifting the evidence it would seem that in the overwhelming majority of cases, Miles, who merely restated the old conviction, is correct, but that in a small number there is unquestionably a considerable spread in the wall of the bowel itself.

A more complicated problem is presented by the extramural lymphatics. Again quoting Miles, "from the anorectal glands which are scattered over the surface of the rectum, efferent vessels pass in three directions—downward, laterally and upward. Those from the anal canal cross the ischio-rectal fossa, pass through Alcock's canal and terminate in the internal iliac glands. Those from the lower part of the ampulla traverse a plexus situated between the levator ani and the recto-vesical fascia, enter a gland near the obturator vessels and thence pass to the internal iliac glands, whilst those from the upper part of the ampulla accompany the superior hemorrhoidal vessels behind the rectum to enter the retro-rectal glands from whence they proceed along the line of origin of the pelvic mesocolon to the glands grouped at the origin of the left common iliac artery. From the uppermost ano-rectal glands also lymph-vessels pass to the paracolic glands situated along the mesenteric border of the pelvic colon." From this description he proceeds to define these zones of spread with the anatomical structures involved. (1) The zone of downward spread including the peri-anal skin, the ischio-rectal fat and the external sphincter muscle; (2) the zone of lateral spread comprising the levator ani muscle, the retro-rectal lymph-nodes, the internal iliac glands, the base of the broad ligament; (3) the zone of upward spread, which he considers the most important of the three, embracing the pelvic mesocolon and adjacent parietal peritoneum, the paracolic lymph-glands and the groups of glands situated at the bifurcation of the left common iliac artery. Upon this anatomical foundation Miles postulates his ideal operation, a combined operation beginning with laparotomy in order to deal with the zone of upward spread, intra-abdominal liberation of this entire area and the greater portion of the zone of lateral spread, the establishment of an abdomi-

nal anus and finally the removal from below of the zone of downward spread and, as the dissections meet, of the mobilized portions above. It is a beautifully conceived procedure developed after the idea of the French school led by Quénu and Hartmann. Unfortunately he does not give his figures of operability which plays such a rôle in mortality, but the death rate is high as follows (reported in 1920):

Operation mortality		
First series .....	42 cases	40%
Second series .....	19 cases	26.3%
Third series .....	11 cases	18.1%

Owing to the war seventeen of the forty-eight patients who survived the operation could not be traced. Sixteen were alive and well for periods varying from six to eleven years. Percentage of cures by total operations, 21.4 per cent.; by survivals, 33.3 per cent. In the face of these excellent results the serious and valid criticism of Miles' operation was its high mortality. In the hands of those who attempted the procedure with less experience, it showed an immediate mortality of not less than 50 per cent. It is impossible to popularize such a deadly form of treatment. It is worth noting here that the data used by Miles in working out his zones of spread along the lymphatic efferents have been modified and extended in some respects by recent researches of Villemin, Huard and Montagné (1925). They have shown that each of the parts of the rectum corresponds to a distinct lymphatic territory having its own collectors and that these collectors can be divided into two groups independent, the one from the other. Owing to the surgical significance of this observation they recommend abandoning the old anatomical division of the rectum for a simpler division on the basis of lymphatic distribution. The lowest value of Houston is at the level of the cul-de-sac. Above this the rectum is partly covered with peritoneum and is to be known as the pelvic or upper rectum (*haut rectum*). Below the valve is the perineal or lower rectum (*bas rectum*). The arteries, veins, lymphatics, and nerves of the upper rectum are all in origin or destiny abdominal. The blood and lymph supply of the lower rectum is mixed in its distribution only the smaller portion being derived from the abdomen, the remainder as also its nerves, coming from without. Lymphatic injections in the lower rectum spread upward to the last valve of Houston, but never beyond, leaving the rectum at that level. Injections above the valve spread downward but are arrested at the valve. There is no such limitation at the rectosigmoid junction. The lymphatic efferents are divided into three groups corresponding to the three arteries of supply. The superior division following the superior hemorrhoidal vessels reaches the abdominal group of glands. The two divisions corresponding to the inferior and middle hemorrhoidal artery, pass chiefly to the perineal, parietal and pelvic groups of collectors but, important to note, separate channels exist to the inguinal glands and to the intra-abdominal glands. This lower system of collectors therefore is never filled by injections from the upper rectum, but the abdominal glands may be filled



from the lower rectum. Their deduction is that cancer of the upper rectum should be removed by an operation exclusively abdominal; secondly, cancer of the low rectum should be removed by abdomino-perineal operation. In the abdominal stage the ligation of the inferior mesenteric artery should be placed above the origin of the superior left colic artery since trunks are demonstrable leading from the lower rectum directly to the glands at this point. These glands must be considered therefore as part of the first barrage concerning which Cuneo says "as long as this is not passed by the growth, surgical intervention is still possible. This obstacle forced, the dissemination of cancerous elements renders impossible all radical operations." The possible application of these observations must be given serious consideration not only, however, with reference to ultimate cure, but in relation to the question of mortality raised by Miles' statistics of the ideal operation. In the attempt to ameliorate this handicap and retain the advantages of complete excision, several two-stage operations were devised. It has been noted above that Quénu in his first combined operation separated the perineal from the abdominal stage by an interval of six days. Procedures were devised by W. J. Mayo, Dahlgren, Coffey and others. Some of these methods carried the first stage to the point of severing the pelvic colon and its circulation completely from their upper connections, after which the pelvic peritoneum was sutured above these structures which were packed down into the pelvis for removal at the second stage several days later. Coffey attempted to make use of the invagination method by drawing the upper bowel down through the rectum and leaving it for removal later. By whatever procedure this was attempted, however, it was found that gangrene occurred in a large proportion of the cases and a very fatal infection of the huge denuded space resulted with high mortality. Mayo simplified the plan by confining the abdominal procedure to an exploration and a colostomy. Subsequently the rectum was removed with great safety by the sacral route. He later elaborated the intra-abdominal stage by tying the superior hemorrhoidal artery and the vascular arch. In order to avoid gangrene the sides of the pelvis and the middle sacral artery were left untouched. Chalot had tied the superior hemorrhoidal in one of the earliest operations in order to diminish hemorrhage in the second stage which, however, was carried out immediately. Quénu practiced ligation of both internal iliacs. Even with these precautions Mayo had a case of perforation of the bowel due to vascular insufficiency. The difficulties due to circulatory causes had engaged the attention of the Germans, especially in their desire to preserve the function of the sphincter. Gangrene of the segment of the bowel brought down to the perineum was frequent and failure of anastomosis in part at least was the rule. Infection of the pelvic space or peritonitis largely due to this complication furnished the greater part of the immediate mortality. The much quoted research of Sudeck gave the rational explanation. He showed that the superior hemorrhoidal artery is for all purposes an end artery. It is, however, connected at some point with the anastomosing arcade of the descending colon and sig-

moid. It follows therefore that the vitality of the upper rectum will be lost if the superior hemorrhoidal be tied below the point of entrance of the anastomosis with the marginal arcade, but will be maintained if the ligature be applied above that point. This is the so-called critical point. Rubesch pointed out that the important anastomosing branch sometimes enters the left primary branch of the superior hemorrhoidal artery instead of its main trunk. In this case ligation of the hemorrhoidal artery immediately above this point would leave half the upper rectum unsupplied, and the critical point would be above the bifurcation of the superior hemorrhoidal. Whenever in the course of the two-stage operation it is necessary to settle this point, it should be determined by study of the area of anastomosis which varies in individual cases or, in case of difficulty in fatty mesentery or unusual arrangement, the ligation should be made at least as high as the beginning of the superior hemorrhoidal or above the origin of the last sigmoid artery. So far as is known, ligation at the promontory will always conserve the blood supply of the rectum. These observations have been amply confirmed by Rehn, Manasse, Quénu, Archibald and Mondor. The latter objects to the emphasis placed upon the critical point, declaring with truth that a critical area should be considered which includes not only the point of ligation of the artery, but the mesocolon containing the vascular arch. It is obvious that the arch must be respected wherever the ligature be placed, since the nourishment of the bowel then depends on a single source of supply through the mesenteric arcade. In the one-stage amputation it is unnecessary to consider this vascular arrangement, but in the two-stage operation, or in any procedure which aims at restoration of the pelvic rectum or even in the establishment of a sacral anus, it is quite necessary to respect these conditions in order to avoid gangrene in the neighborhood of the rectosigmoid junction. This applies also to any operation which would resect the sigmoid within the abdomen and leave the distal portion as a blind pouch. In order to fulfil the requirements of the combined excision it is necessary to resect at least the lower sigmoid mesentery containing the superior hemorrhoidal artery in order to remove the abdominal lymph vascular tract. It remains to be seen whether this is sufficient in all cases. The studies of the lymphatics above quoted, as also clinical observations of Jones, Moynihan and others, indicate that in some instances at least the section of the blood and lymph supply must be at a higher level. At all events it is a minimum requirement to remove the bifurcation of the superior hemorrhoidal with its neighboring tissues. This is called by Mondor on account of the confluence of the blood and lymph supply at this point, "the hilum of the rectum."

Daniel Fiske Jones in 1915 published his modification of the two-stage abdomino-sacral method which permitted wide removal with great safety. The sigmoid and descending colon are mobilized and the inferior mesenteric tied just below the left colic branch. The peritoneal flaps are reflected from the mesentery of the lower sigmoid and rectum. The whole pelvis is dissected from the promontory above and the ureters laterally. The bladder is

freed anteriorly. The upper rectum and sigmoid are thus detached from their intra-abdominal connections, are held forward, and the peritoneum sutured behind the bowel and close about it. If the sigmoid is to be brought down to the perineum the abdomen is closed. Otherwise an abdominal anus is made high in the sigmoid. A week or so later the coccyx is removed and the perineal amputation or resection completed. Jones has always been reluctant to preserve the sphincter because of the danger of incomplete removal of the disease. In 1922, he was able to report ninety-two abdomino-perineal operations with twenty-three three-year "cures," a percentage by number of operations of 25 per cent. and by survivals of 40 per cent. The mortality in his series was largely in the early cases before the method described had been worked out. He had performed an increasing number in one-stage as familiarity with the procedure increased. In the last eighteen combined operations there had been no immediate mortality. This low mortality was obtained in a group with the operability figure of 60 per cent.

In the same year (1922) Coffey presented a detailed and beautifully illustrated plan of combined operation which has attracted much attention. Impressed with the importance of the upper zone of spread he has adopted the abdominal anus as a routine. Through an abdominal incision the lower sigmoid is detached and together with the upper rectum is completely mobilized. The freed tissue is then disposed of, either by evaginating it through the anus, or by amputating a portion of it if the growth is high, in which case the lower segment is closed and allowed to remain. If evagination cannot be accomplished because of stricture or excessive mass of the liberated tissue, the latter is cut away before the lower segment is inverted and closed. The pelvic peritoneum is then repaired. Drainage of the potentially infected pelvic space is accomplished through the vagina in the female and in the male by placing a large suprapubic drain which is isolated from the abdominal cavity by drawing over it posteriorly the lateral peritoneum from the sides of the pelvis and bladder, thus constructing a tubular drainage area to the surface emerging at the lower angle of the wound. At the second stage the lower rectum is speedily removed through the vagina in the female or the posterior perineum in the male. He reports thirty-seven cases with two deaths (5.4 per cent.). End results are not yet obtainable. If one might venture to predict the outcome, we would prophesy an undue percentage of ultimate failures due to insufficient removal of the downward and lateral zones of spread. However, we believe that the mortality would not be materially increased by wider excision at the second stage, and it is the merit of this operation that it has shown as had Jones that a complete intra-abdominal procedure is not incompatible with low primary mortality.

It is unfortunate that the French surgeons who have been using the combined method for years have not shown equal pains and persistence as the Germans in collecting their end results, but such seems to be the case.

Scarcely a single point of advantage is alleged by advocates of the one type of operation but is resisted by denial or the presentation of offsetting

factors by those in the opposite camp. Perhaps we can best come to some sort of agreement by stating those points concerning which there is almost unanimous consent.

(1) In spite of the many instances of low malignancy and late metastasis observed in cancer of the rectum, permanent cures have increased in number *pari passu* with wider ablation of related tissue.

(2) There is no debate concerning the liability to metastatic involvement of the upward zone of spread in a certain percentage of cases.

(3) From the sole standpoint of cure, therefore, there is excellent reason for including this area in the bloc to be removed.

(4) Complete removal of this area in most cases can be carried out only by the aid of previous intra-abdominal mobilization.

(5) Those who do not practice consistent and complete removal of this zone limit their procedures for other reasons than those which have to do with permanent cure, *e.g.*, mortality, morbidity, wider applicability, less frequent necessity for abdominal anus and a feeling that their results are practically as good.

We have already considered the difficulties of statistical estimate of comparative mortality. In the one-stage operation the danger of shock is undoubtedly greater in the combined than in the sacral operation. On the other hand, the danger of infection immediately subsequent to operation is greater in the latter. Practically all considerations of post-operative deaths in the low operations show that more than half of the fatalities are due to infection of the pelvic space or to peritonitis. To this number might fairly be added a certain proportion of deaths due to vascular, heart and lung complications. Probably not less than 75 per cent. of all deaths are infective. The greater security in aseptic technic by the combined method should and does obviate or mitigate a large proportion of these infections. By the two-stage method infection as a serious factor is largely abolished, whether the operation be of the complete or limited type. Naturally by the limited type in which the abdominal procedure is practically only a colostomy, the mortality is lower. This is Lockhart-Mummery's platform and restricts the argument to the actual advantage to be derived from the more complete operation which must wait on further experience. There is no question, however, even in Lockhart-Mummery's mind, that if the complete procedure could be performed with equal safety the end results would be superior. If it be objected that Miles' present mortality of 18 per cent. is too high, it suffers little by comparison with the mortality of the foremost German surgeons performing the radical sacral operation and is lower than that of many. Also the lowest mortalities achieved in any reasonably large series are those of Coffey and Jones who employ the combined method. It seems clear that the attainment of a low mortality by the combined method rests (1) on the use of a rational, well-standardized method and sufficient experience to carry it through without unnecessary delay or avoidable accident and (2) on the exclusion of those cases who would be unsuitable for any severe procedure whether by reason of

age, obesity or debilitated condition. To overload the operation with those who cannot endure it and to deny those who can endure it, the added security which it affords is equally unwise.

The morbidity of the complete operation, whether combined or sacral, is high owing to the large pelvic space which does not permit of healing by first intention. Here the advantage is distinctly with the two-stage operations on account of greater freedom from severe primary infection.

It is unnecessary to review to a surgical audience the question of colostomy. By all except the German surgeons it has been decided that an abdominal anus is preferable to an uncontrolled sacral opening. The preservation of the sphincter is not a point of contest between the two types of operations since the continuity can be restored equally well, if not more safely, by a previous abdominal mobilization as by the sacral route. It is true, however, that most surgeons who are sufficiently impressed with the necessity for wide excision to prefer the combined method are rarely willing to preserve the sphincter with its essential surrounding tissue and nerves, because of the danger of recurrence.

The permanent results of the newer operations must wait. I regret that my own cases are too few and recent to add. Enough is known to warrant the belief that the percentage of cures will be increased. Certainly wider excision could not decrease the prospect of cure. It is our belief that the radical combined operation will win the day and that the perineal or sacral operations will be restricted to cases unable to endure the more exacting procedure.

Körte stated that this operation is the most difficult in surgery. Chalier and Mondor reply that it is only necessary to learn it.

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# ASEPTIC TECHNIC OF STOMACH RESECTIONS

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IN THE majority of operations pertaining to modern gastro-intestinal surgery the temporary opening of the organs involved is unavoidable so that it depends on the surgeon's skill only how to evade the soiling of the wound and abdominal cavity by the infected contents of the organs in question. How to close the wide temporary openings caused by the resection lines, quickly, safely and in an aseptic way, stopping hemorrhage at the very same time as well, is a question which has been much discussed ever since the beginning of modern abdominal surgery.

By the method of Doyen—*i.e.*, the crushing of the bowel wall by means of a crushing-forceps, double ligation in the crush furrow and division in the middle, followed by a purse-string suture—the quick and aseptic closure of a normal jejunum, for instance, is a very easy task even for the beginner, but this reliable method of Doyen cannot be used on the stomach, nor in many cases on the colon and is useless in some cases of intestinal obstruction also, as we usually find the oral loop of the strangulated bowel greatly dilated much beyond its normal size.

In these cases we used to close first provisionally the organ in question by means of a forceps or crushing clamp—such as, for instance, Kocher's Graser's, Payr's, etc., and then complete an exact hand-made suture close behind, or in the narrow sewing-slit of the clamp in question. After that removing the instrument and finishing the definitive closure by one or two rows of continuous sero-serous sutures. This way of closing is neither quick, nor aseptic enough and requires much skill and practice from the surgeon.

As for the lack of rapidity of this method, I have only to point to the enormous technical difficulties attending the closure of a retracted cardial stomach-stump after a subtotal resection because of advanced cancer, where the provisional closure must be done in a deep and in a hidden place, sometimes hardly accessible even for the surgeon's hands. These technical difficulties may suggest to the surgeon to proceed in a less radical way than is necessary.

As for the aseptis of such a procedure, we cannot consider it aseptic at all, simply because the thread has to pass many times through all tissues and through the infected contents of the organ as well and becomes thoroughly soiled by different germs after the very first of the stitches.

How serious the consequences of such soiling of the operation-field with germs of this said origin may be are shown by the words of *Kelling*: "As for the mortality rate incident to stomach resections I have come to the opinion, that the most of them: such as the sepsis, pneumonia, gangrene of the lungs, the local and general peritonitis and none the less the leakage of our

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sutures also, are due to *one* reason in general: to the soiling of the tissues (peritoneum, mesentery, stomach-cut, etc.) by the infected contents of the cancerous stomach."

It is a matter of course that when doing a suture the hands of the surgeon and none the less the operating field, should be kept clean from being soiled with the utmost carefulness. Easy to say—but very often impossible to do it!

In many cases of stomach and of other resections, the mobilization of the organ in question is a simple task, and it is the easier for the surgeon to avoid infection, the better he can lift the object of his operation above the abdominal wall of the patient, but as a rule—and especially when resecting a stomach with advanced cancer—the greatest difficulties may be met with and we are forced to complete the provisional closure of this organ, usually much retracted underneath the thorax, where there is but a very little room for the surgeon's hands, and no room at all for protection with sterilized gauze-towels. The large number of different stomach-clamps is the best proof of the fact that the surgical-technical part of this question has suffered from more than one weak point. To mention the most used

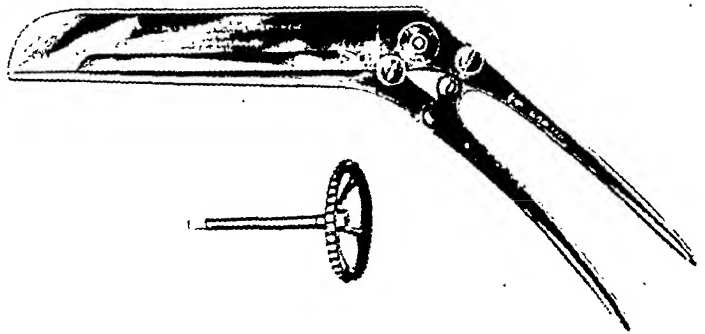


FIG. 1.—Stitching forceps and removable handle.

types only: amongst the clamps of *Kocher*, *Graser*, *Payr*, *Lanz*, *Bakes*, *Gossel*, *Gelinsky*, *Marro*, *Moynihan*, *de Quervain-Graser*, *Lane*, *Alvin Ach*, *Scudder*, etc., we may observe a certain advance inasmuch only, that instead of the flexible forceps of the earlier periods more rigid crushing-clamps have won popularity everywhere, some of which are combined with narrow sewing-slits also.

To make provisional closure easier, quicker and more aseptic, two different kinds of mechanical contrivances have been brought to the market: the stitching instrument of *Florian Hahn* and the ponderous and complicated stitching forceps of *Hüttl-Fischer*.

From the practical point of view none of these stitching mechanisms was able to supplant the old hand method. Although I have personally more than once experienced the imperfection, unreliability and clumsiness of both these instruments, nevertheless by the fact, that the hand-made closure can be considered neither quick, aseptic, nor reliable enough, I have been led to create an instrument more fully corresponding to all demands. (Figs. 1 and 2.)

This instrument is simple, reliable, aseptic, saves much time, and simplifies resections to a marked extent. Even the most skilful of surgeons needs ten or fifteen minutes at least to complete an exact provisional closure of the

newly formed stomach-end when resecting this organ. By means of the instrument presented, the same task is done in half the time, because the instrument is completing two rows of sutures at the very same time!—and the whole procedure does not require more than ten seconds altogether!

After having gently pressed the contents of the stomach toward the pylorus, one closes the instrument at the very point of the organ where we want to perform resection-line, and after having adapted the removable handle, we turn it three times, then remove it, and remove the opened clamp also.

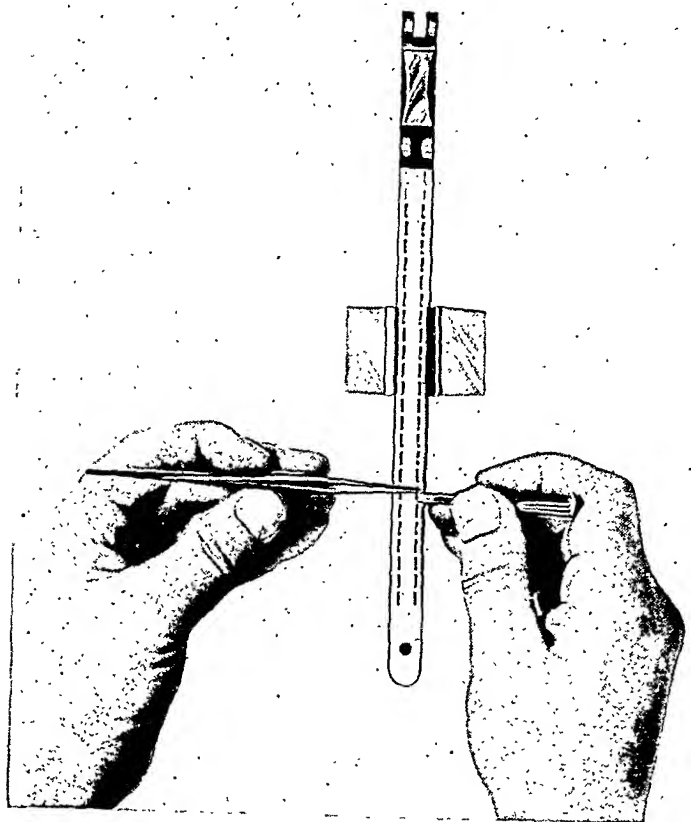


FIG. 2.—Filling up the stitching forceps. The removable upper part is placed at the container and the fine U-shaped new-silver hooks are pushed one after another in the holes of the clamp by means of a pincett and filling pin.

tight way toward the oral, as well as toward the aboral side. (Fig. 3.)

The crushed furrow situated between the two parallel rows of these new-silver hook-stitches is a quarter of an inch wide, and is large enough for the simple division with a straight scissors in the middle.

The fine U-shaped new-silver hooks pressed in the stomach wall, and covered by an inverting suture, have no dangerous consequences at all. X-ray examinations have repeatedly shown that within two to three weeks they fall into the cavity of the organ. As they are round and cannot stick to the mucous membrane of the digestive tube, they are emptied with the stool of the patient, like the anastomosis button of Murphy.

*Filling and Sterilizing the Stitching Instrument.*—The filling of the stitching clamp with the small U-shaped new-silver hooks is a task of six or seven minutes only and should be done by the nurse before operation. For



this purpose the upper part of the clamp must be removed by the simple way of unscrewing two hand-screws, and at the small container, which is attached to every instrument placed. The fine U-shaped hooks are pushed one after another in the holes of the clamp by means of a pincett and a filling-pin as demonstrated in Fig. 2.

To prevent mistakes when filling the instrument, such as to miss one hole or to put two hooks in one and the same hole, it is best to place the filling pin in the very next of holes we wish to fill, while the pincett in our left hand is picking up the next hook from the box. The hooks should be pushed so deep in the holes, that their pointed ends just disappear. Each of the two hook rows is composed of twenty-three hook-holes, giving a length to the crushing surface of five and a half inches. This is large enough for the most dilated stomach.

As for the sterilization of the stitching-clamp, it is not different in any respects from the sterilization of other surgical instruments. It should be boiled with the other instruments when filled.

To warrant an unlimited durability to this instrument, made out of hand-forged non-rusting steel, nothing else is required than to clean it with a nail brush and petroleum and to dry it.

*When Can the Stitching Instrument be Used?*—The instrument can be used in all cases of stomach and colon resections without regard to the kind of anastomosis following. It may be used as well in the case of a side-to-side as in the case of an end-to-side and none the less in the case of an end-to-end anastomosis, which circumstance simplifies the sleeve-resection of the stomach, for instance, to a very considerable extent.

As for my part I used to prefer the original Billroth No. 2 stomach resection method, completely closing the newly formed proximal end of the stomach and making a posterior gastrojejunostomy.

Polya's and Mayo's modification I am following only, when because of extensive retrogastric adhesions or because of the subtotal resection of the stomach—in cases of advanced cancer—there is no room at the retracted back wall to complete an anastomosis large enough.

In these cases after having completed the provisional closure of the resection line by means of the stitching instrument and having dissected the

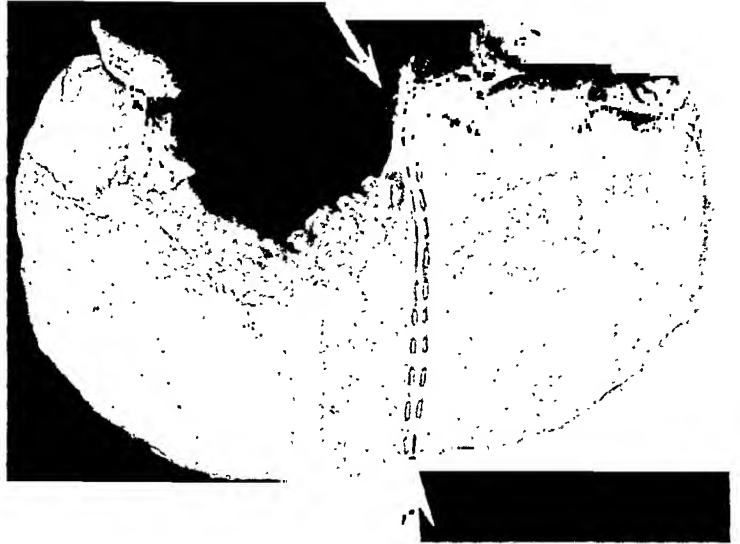


FIG. 3.—Two rows of new-silver hook-stitches at both sides of the crushing furrow of the stomach. The line of resection (marked by arrows) is closed in a quick, aseptic and water-tight way toward the oral, as well as toward the aboral side. The crushing furrow must be simply divided in the middle with a straight scissors.

crush furrow between the lines of hooks and after the first row of sero-serous continuous silk sutures, begun at the lesser curvature, has united the back wall of the stomach for half an inch behind the hooks and corresponding loop of jejunum, I used to cut away a certain number of the hooks with a small portion of the newly formed stomach-end in a length slightly longer than the diameter of the jejunum and as wide as a quarter of an inch only.

In the cases of Polya's modification the hooks of the middle portion of the newly formed stomach-end must be cut away and in the cases of Mayo's modification those next to the lesser curvature are to be removed by means of a curved scissors. The rest of the hooks are first covered by three or four inverting silk sutures and then by a continuous inturning silk suture, begun at the greater curvature if we are using Mayo's modification and begun at both curvatures if we are following Polya's modification.

The jejunum is now opened opposite to this point, a half of an inch from the first suture line and the ordinary technic is completed. The opening being closed, the very first sero-serous silk suture is continued over the anterior portion, protecting still further the closed end of the stomach by suturing over it the unopened bowel.

For the last four years I have been using the stitching clamp in all of my cases of stomach resection. Based upon my good experiences with respect to the immediate and after results, I have found no reason for returning to the imperfect hand-made way of provisional closure, the less, because by means of my stitching clamp the completed operation can be made within half an hour and we all know of what importance the abbreviation of the operation must be considered in abdominal surgery.

Those surgeons especially, who are following the radical standpoint of *Perthes* in the much discussed question of simultaneous stomach-colon resection (resection "en bloc") in the desperate cases of unseparable adhesions between stomach and transverse colon and in the cases of propagation of the cancer at the transverse mesocolon, will find a very useful instrument in these stitching clamps. For this kind of "en bloc" resection two pairs of stitching clamps are required.

During the last four years I have had two cases among my operations for stomach cancer, which have forced me to make a simultaneous resection of the transverse colon also and both of these patients recovered from the operation. This is a most satisfactory result if we take into consideration, that the mortality rate incident to this radical kind of operation is characterized by more than one prominent surgeon as "frightfully high."

# PERFORATED ULCERS OF THE DUODENUM\*

A STUDY OF TWENTY-SEVEN CASES

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IN 1921 the writer presented before the Surgical Section of the New York Academy of Medicine, fifteen cases of acute perforation of the duodenum by ulcers. Simple closure of the perforation by inversion, with or without omental reinforcement, was advocated as the procedure of choice. A concomitant posterior gastro-jejunostomy seemed indicated in but a small minority of cases.

Since the presentation of these cases the writer has accumulated the personal experience of twelve more cases. The results obtained in these added cases substantiate the advisability of simple closure in most cases.

Before considering these supplementary cases and reviewing those previously presented, it must be emphasized that perforation by duodenal ulcer only is under consideration and pre-pyloric lesions are excluded.

In this most dramatic of acute abdominal crises, operation within the first twelve hours with simple closure of the perforation will terminate in recovery in the vast majority of cases. The question is whether such ulcers are cured by simple inversion closure and if the patients remain well and asymptomatic.

In the light of the experience gained by the twenty-seven cases enumerated the writer proposes to discuss the operative procedure that seems to offer the best—not only immediate, but end results.

But before doing so a better understanding can be had if some anatomic relations and physiologic functions of the duodenum are briefly reviewed.

The cardiac orifice and the first part of the duodenum are fixed parts of the stomach. When empty the stomach lies transversely in the upper abdomen; but when filled it assumes a vertical shape which is due to the descent of the prepyloric part. In accord with gravity therefore, the weight-bearing part of the viscus is in the distal part of the pylorus and that part of the duodenum adjacent thereto. This pendant portion of the stomach, which includes the pylorus, the first part of the duodenum, and the distal part of the lesser curvature has a blood supply that is considerably less than the stomach proper. Also in addition to this subvascularization the mucosa is here intimately attached to the muscle layers forming rugæ.

These peculiarities of anatomic detail allow very little dilatation or contraction and the consequent rigidity predisposes more or less to traction anæmia. The anæmia peculiar to this locale lasts about two hours after

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\* Read before the Surgical Section of the New York Academy of Medicine, May 6, 1927.

eating and may be regarded as a potent predisposing factor for selective embolic infections, thrombosis or tissue digestion. This anæmia also influences the healing of ulcers occurring in this area subsequent to operative interference. For that reason by raising the foot of the bed about six inches the gravity change thus brought about will overcome this traction and the blood supply will be materially increased.

In the process of digestion, when food enters the stomach, it becomes liquified and mixed with the gastric juice and the sphincter at the pyloric extremity does not relax until chymification is complete. The balance between the motile powers of the stomach, as shown by the retention of its contents and their later propulsion through the orifice of pylorus, is properly maintained. These motile powers are probably segmental in each curvature.

This motility mechanism, however, is badly deranged by gastro-enterostomy. Normally the acidic chyme when it flows into the duodenum transforms the prosecretin into secretin and thus establishes pancreatic secretion. The churning movement of the duodenum intimately mixes the chymified food with the bile and pancreatic ferments and then passes it into the jejunum. Gastro-enterostomized patients are subject to a change that may be termed revolutionary in so far as the physiology of their digestion is concerned.

Gastric contents that are improperly prepared enter the jejunum which in consequence must do the work of the duodenum, a part of the process of digestion for which it has no physiologic fitness. The subjective and objective sequences of this digestive dysfunction may be pain, vomiting, diarrhœa—in fact, the whole gamut of dyspeptic signs and symptoms. That many of these patients thrive despite this handicap only shows the adaptability of the human economy.

It is nevertheless true that gastro-enterostomy performed for the purpose of relieving scar tissue obstructing the pyloroduodenal orifice is, in the majority of cases an entirely satisfactory procedure.

In such cases of obstruction there has existed for some time an altered function, both motile and secretory; mostly of the stomach, to a less degree of the duodenum. For that reason, one chooses the lesser of two evils and makes a short circuit, trusting to Nature's well-known tendency to establish a satisfactory balance.

Conversely, it is well known that in the absence of true pyloroduodenal stenosis, gastrojejunosomy is often fraught with future disaster. For several months the patient is likely to be comparatively free from symptoms, but later results may be most disappointing.

The cardinal indication, therefore, for gastro-jejunosomy would be actual or organic stenosis.

This form of stenosis did not obtain in the majority of the cases cited here, and from discussion with colleagues the impression would seem to prevail that in relatively few perforations from duodenal ulcer does real stenosis occur.

Moreover it must be remembered that nature overcomes many apparent

stenoses. This fact is well demonstrated in three cases, which were subsequently operated upon for (a) incisional hernia; (b) acute suppurative cholecystitis; (c) gastro-jejuno-colic fistula.

The duodenum in all three cases was restored to normal yet apparent stenoses presented at the time of perforation and in one case it was so pronounced that a primary gastro-jejunostomy was added. The evidence in these three cases was convincing testimony of how completely restored to normal the diseased duodenum may become. Not only was there no evidence of scarring, but practically none of adhesions. The writer is of the impression that should the diameter of the duodenum be reduced not more than one-half, due to the infolding of the perforation, no stenosis will obtain.

Pathology: Of the well-established, easily demonstrable chronic ulcer we have ample knowledge; of the so-called acute ulcer, the erosion, the ulcerating lesions which recover and disappear under medical treatment, our knowledge is meagre. It is highly probable that from time to time small defects occur in the gastric and duodenal mucosa, with or without symptoms, and that these spontaneously disappear. Defects of greater magnitude, true ulcers with typical clinical findings, sometimes completely disappear under medical treatment. The so-called remissions and exacerbations in these histories may be explained upon the ground of recurring new ulcers. Once the lesion has become a well-established indurated type the pathological process is prone to become progressive with little or no remission of symptoms. These true surgical ulcers present five general types:

(1) The large ulcer with much scar tissue formation encroaching upon the lumen of the duodenum and accompanied with more or less extensive extrinsic adhesions.

(2) The medium-sized ulcer with moderate scar-tissue infiltration, without narrowing of the lumen.

(3) The small ulcer with a non-indurated or only slightly indurated base.

(4) The actual necrotic ulcer.

(5) Multiple ulcers, including the so-called "kissing" type.

Perforation may occur in any of these, and as the pathology is varied so also are the indications for surgical repair. To dogmatically state that suture with posterior gastro-enterostomy should be employed in every instance is as illogical as to assert that simple closure will always suffice. Good surgery aims to cure the patient with the least insult to anatomic and physiologic function.

Clinically most acute duodenal perforations are those of types 2, 3 and 4. There is a remarkable monotony of appearance to these lesions. They are simple, single, round, slightly indurated, 1 to 2 centimetres in diameter, on the suprapapillary part of the duodenum (the proportion is 450 to 1) and nearly always in the first 1½ inches of the anterior or superior surface. Those occurring at the junction of the pylorus and duodenum are probably for the most part duodenal. In these the pyloric veins are often obliterated. Much less than half of those ulcers present adhesions to neighboring structures;

the gall-bladder, liver, colon, stomach and omentum. Most ulcers that perforate suddenly are non-adherent to adjacent viscera, and when adhesions are present in such they are almost invariably of recent origin. Disease of the appendix and gall-bladder is a frequent concomitant.

The perforation is usually from two to five millimetres in diameter, a typically punched-out hole in the crater of the ulcer. If carefully examined it will be noted that the entire ulcerating portion is extruded as the result of embolism or thrombosis. The remaining peripheral induration is the protective zone that accounts for the rapid healing of the lesion after closure. The writer believes that in many cases this induration is soon absorbed and the duodenum is restored to its normal condition without any macroscopic evidence of previous disease. Thus one seems justified in stating that lesions of types 2, 3 and 4 which form the majority of duodenal perforations are best treated by simple closure.

The large ulcer with an abundance of scar-tissue induration which encroaches upon the lumen of the duodenum and which usually is adherent to neighboring organs, presents a different pathology and demands appropriate surgical therapy. Such lesions, prior to perforation, have produced a partial stenosis thereby resulting in a change in the motile and secretory functions of the stomach. The closure of these ulcers after perforation usually produces a real rather than an apparent obstruction. Consequently they present the cardinal indications for gastro-enterostomy, namely, stenosis plus a preëxisting altered gastric function. (Perhaps some form of pyloroplasty of the Finney or Horsley type may prove efficacious in the therapy of these types.) Furthermore, simple closure in this type seldom results in permanent cure, and the relapses after such a closure have helped to popularize primary gastro-enterostomy for all types. The treatment of the multiple ulcer type must be governed by the pathological problem at hand.

From the above-mentioned pathology, it will be noted that for practical purposes perforated ulcers of the duodenum conform themselves to one of two types. First, the soft lesions—the more common type—characterized, (a) by their relatively smaller size, (b) by their superficial extent, (c) by their failure to penetrate deeply prior to the embolic or thrombotic phenomenon which results in perforation, (d) by the absence of dense induration, and (e) by lack of adhesions and encroachment upon neighboring structures. Second, the calloused type, characterized (a) by their large size, (b) by their deep penetration, (c) by their dense induration, (d) by their firm adhesions to neighboring structures, and (e) by their tendency to produce mechanical complications. The writer believes that simple closure by inversion with fine chromic catgut will cure the vast majority of the first group, whereas the calloused types require in addition a primary gastro-enterostomy (or perhaps some form of pyloroplasty). The successes and failures in this series are in accord with these general principles.

The diagnosis of perforation can be easily made in most all cases. The anamnesis of previous indigestion, the suddenness of onset, the agonizing

pain, constant in character in contradistinction to the colic-like pain of appendicitis, cholecystitis, intestinal obstruction or renal colic; the vast extent and the degree of rigidity and tenderness so soon after onset, the comparatively slow pulse, slight or no febrile reaction is a familiar picture. A few points are worthy of emphasis; vomiting occurred in less than half of the cases in this series (12 cases). Rectal examination may elicit extreme tenderness soon after perforation much earlier than in appendicitis. The symptom of shock has been overemphasized. In this series but 7 were in any degree of shock. Apparently shock, when present, occurs soon after perforation, and is transitory. It should also be mentioned that in stout individuals there is only moderate rigidity. Also in the transitional period passing on to true peritonitis, there is a free interval when the pain is ameliorated. One patient (Case III) seen eighteen hours after perforation sat up in bed exclaiming, "He felt quite well." No opiate had been administered. His abdominal cavity contained the usual amount of duodenal contents and the peritoneum was markedly injected. More than half the cases show obliteration of liver dulness either partial or complete. It is merely a corroborative sign and is in no wise pathognomonic. The left shoulder pain, mentioned as occasionally occurring early after perforation, is probably a pneumogastric-spinal accessory reflex rather than pain of peritoneal or anginal origin.

In the preperforative irritation stage, physical examination may reveal acute tenderness over the ulcer with some rigidity of the overlying muscles. This connotes a deep ulcer with peritoneal irritation and should be an indication for surgical intervention. (Case VII well illustrates this danger signal: The patient, a female of fifty-seven years, for six months had typical hunger pains occurring three hours after eating. Her examination elicited acute tenderness over the site of the pylorus and moderate rigidity of the rectus. Temperature, pulse and blood count were normal. She was put to bed and placed upon Lenhartz diet. Tenderness and muscle spasm persisted. On the eleventh day of treatment, perforation occurred suddenly while she was at absolute rest.)

*Treatment of Acute Perforations.*—The treatment of acute perforation is immediate operation regardless of any degree of shock that may be present—as the patient's condition rapidly improves with the relief of intraperitoneal tension. A four-inch mid-right rectus incision is deepened down to the peritoneum. A point of practical importance is to determine the lower border of the liver. This should limit the upper angle of the incision. If a small nick be first made into the peritoneum, a little free fluid will well up into the incision, and gas bubbles erupting through this will clinch the diagnosis of perforation. The escaped contents are best aspirated, especial attention being paid to Morrison's space, the right lumbar gutter, and to the toilet of the pelvis. With moist pads the surrounding structures are gently pushed aside and the perforation sought. Fibrin deposits are an excellent guide to the point of perforation and not infrequently gas bubbles point out the way. If the perforation is obscure, slight pressure on the stomach may cause bubbles

to appear. Closure of the perforation is accomplished by infolding the ulcer with fine chromic catgut reinforced occasionally with an omental tab. The expediency of a primary, gastro-jejunostomy is determined by the pathology. If simple closure is performed, one tests the patency of the lumen of the gut. If the tip of the little finger can be insinuated through the site of closure, there is little danger of obstruction. One then makes a search for secondary ulcers, gall-bladder and appendiceal disease.

The added risk of primary gastro-enterostomy, before the advent of peritonitis, is slight in a patient whose condition during operation, as regards respiration, aeration, and circulation, is good. The danger of working in a potentially infectious field is more theoretical than real. The real dangers are two-fold: (1) a 2 to 3 per cent. chance of future gastro-jejunal ulcer formation, and, (2) the late secondary sequelæ which occur in some cases despite perfect technic in the hands of the most skilful. Therefore, unless the pathology is such as to demand a primary gastro-enterostomy, *i.e.*, definite obstruction, simple closure should be performed. A good practical rule is, when in doubt, do not perform a gastro-enterostomy. It can be performed later, if necessary.

If a careful peritoneal toilet be made by aspiration, there is no need of drainage except to the mural tissues. The suprapubic stab wound seldom drains, but may produce adhesions and is contra-indicated. Drainage to the site of closure is never instituted as several duodenal fistulæ have resulted thereby. The slow perforations with abscess formation are best treated by simple incision and drainage. If a fistula ensues, a secondary closure with gastro-enterostomy is indicated.

Following operation the patient is placed in a semi-recumbent position, given one or two doses of morphine and a 5 per cent. glucose rectal drip. Small amounts of water by mouth are permitted after four hours. On the third day, Lenhart's diet is instituted and adhered to for its entire course. At this time, the foot of the bed is kept elevated about six inches. Frequently small amounts of alkalis are administered the first two weeks. The patient is then given a light, selected, non-bulky diet with crackers and milk between meals for the next two weeks. At the end of the month a röntgenologic examination is made. The patient is warned of the dangers of dietary indiscretions and receives medical supervision for at least six months.

This series is comprised of consecutive cases operated upon between October, 1912, and October, 1926. There were 25 males and 2 females; the youngest patient was twenty-one years, the oldest fifty-seven; the average age was thirty-five years. It is interesting to note that no case was obese (*versus* gall-bladder type) and that several of the patients had been under rather severe mental or physical strain for some period of time. Their occupations were varied, no one predominating.

Seventeen patients, 63 per cent., gave a typical previous ulcer history varying from a few months to eleven years. Eight, 30 per cent., presented an indefinite history of dyspepsia. In two cases there were no symptoms up



## PERFORATED ULCERS OF THE DUODENUM

the moment of perforation. (In these the evidence of inflammation and pain were absent and the picture was one of focal necrosis.)

But two cases gave a history of melena, none of haematemesis. Only three cases perforated within the first year of symptoms and the average duration of symptoms until perforation was almost four years.

Of the twenty-seven perforations twenty-four were acute and three slow perforations. Of the slow perforations one presented a large abscess extending from the liver to the iliac crest. This was of two weeks' duration, no other case slowly perforated and remained localized. The third case ruptured into the lesser sac, presenting the clinical picture of duct obstruction with jaundice.

Of the acute perforation (24) the shortest time elapsed after perforation until operation was three hours, the longest twenty-six hours, the average time being ten and a half hours. The average temperature was 99.8 per centum, pulse 88, respirations 25, white blood-cells 15,400 with 84 per cent. polymorphonuclears. Cultures taken in fourteen cases were all sterile. Of the twenty-four acute perforations a correct pre-operative diagnosis was made in twenty-two. One was thought to be a ruptured appendix, one acute hemorrhagic pancreatitis because of the pronounced shock, persistent vomiting and only slight rigidity. Of the twenty-four acute perforations the soft ulcer type prevailed in seventeen cases (70 per cent.) and the calloused ulcer in seven (30 per cent.). Two of the soft ulcers were of the acute necrotic type and were asymptomatic prior to perforation. In all seventeen cases of soft ulcer simple closure was performed. Of the seven indurated type ulcers primary gastro-enterostomy was performed in five cases and secondarily within one month of simple closure in two others. Five cases had concomitant appendectomies performed at the primary operation and two cases, cholecystectomy.

The immediate results in all twenty-seven cases were good save one patient, simple closure, who suddenly died on the fifth day apparently of pulmonary embolism, giving a mortality of 3.7 per cent. One patient in whom a transverse incision was employed returned in three months suffering from an incisional hernia. During repair, the duodenum was carefully searched for the old ulcer site, it had been a soft ulcer type of one year's duration. The duodenum appeared normal. Another developed an acute suppurative cholecystitis requiring cholecystectomy. The duodenum was free of adhesions and the ulcer site had disappeared.

A third case upon whom a primary gastro-jejunostomy was performed, also cholecystectomy and appendectomy, remained well for four and one-half years. He then suddenly developed a gastro-jejuno-colic fistula with the classical syndrome of left-sided epigastric pain radiating to the left groin, ten to twenty daily watery movements containing large amounts of undigested food and a loss of forty-four pounds in weight.

An operation there presented a gastro-jejunal-colic fistula about 2 cm. in diameter. The remarkable feature was the almost negligible pathology at

the former duodenal ulcer site. There was no scarring, no induration, no stenosis and few adhesions. The procedure consisted in undoing the gastro-enterostomy, closing the gastric and colic atria and resecting three inches of the jejunum with lateral anastomosis. The patient was discharged on the sixteenth day. His weight has rapidly increased and to date he is asymptomatic.

These three cases are presumptive evidence that perforation tends to cure the ulcers and that the duodenum is capable of complete restitution to normal even though an apparent or real stenosis obtains after closure.

The average time elapsed since operation is five years and two months, the longest period fourteen years, the shortest eight months. Seventeen patients have recently been heard from. Twelve had simple closure—of these ten are entirely well (83 per cent.). One required a secondary gastro-jejunostomy two years later for hemorrhage, the other has heartburn and flatulence; his gastro-intestinal series is negative. The known end results of five gastro-enterostomized patients is as follows: Two are quite well (40 per cent.), one has dragging epigastric pain with occasional attacks of diarrhœa. His general nutrition is satisfactory; one required a secondary operation for intestinal obstruction from bands about the appendectomy site and another has had the gastro-enterostomy undone for gastro-jejuno-colic fistula.

In conclusion one seems justified in emphasizing the importance of reporting the end results of the treatment of perforated ulcers of the stomach and duodenum as separate entities. The immediate results depend chiefly upon the time interval that has elapsed after perforation. Only by careful follow-up records extending over long periods can reliable statistics be obtained as to ultimate cures. Undoubtedly the duodenum is capable of complete restitution to normal even though apparent or mild degree of real stenosis obtains after closure. The end results of simple closure in this series are much superior to those treated by gastro-jejunostomy. A fuller appreciation of the pathological problem presented in each case should result in more rational methods of treatment. To state dogmatically that all cases treated by simple closure will result in permanent cure is as illogical as to insist upon a primary gastro-jejunostomy as a universal procedure.

# E INTERPOSITION OF SMALL BOWEL SEGMENTS BETWEEN DIVIDED ENDS OF THE COLON\*

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TO THOSE who have occasion to resect extensively the pelvic colon, for growth, diverticulitis, or other lesions, there must often have come the thought of the desirability of uniting the descending colon or stump of the sigmoid with the remaining portion of the rectum—and at the same time an appreciation of how difficult or impossible, in some instances, this may be to accomplish. In the latter part of 1926, the writer was confronted with a specific case, which crystallized this long-considered general problem into a specific demand. As this case initiated the work herewith reported, its general outlines will be related.

The patient had been admitted to the Phipps Psychiatric Clinic of the Johns Hopkins Hospital because of a profound depression. Careful study of the mental status led to the conclusion that the depression was due to a physical disability, which, in turn, was the result of the man's past surgical history. Four years previously, he had undergone a resection of the sigmoid for a lesion which turned out to be diverticulitis. The gap between the sigmoid stump above, and the rectum below, had been considered too great to bring the ends together to anastomose and accordingly, the sigmoid had been brought out and fixed in the midline incision for an artificial anus, and the rectum closed, leaving a short blind pouch below. The patient, after recovery, had resumed his business and social relations, but was much distressed by the incontinent colostomy. This had continued to disturb his mental balance until his depression became, in itself, a major disorder. The psychiatrists believed that if the alimentary tract could be restored to normal, the man's depression would disappear, but that otherwise, there was no method of improving his condition. This, then, was the problem presented to the surgical consultant.

Examination showed a scar from the umbilicus to the symphysis, in the upper part of which was the terminal opening of a loop of bowel. When barium was injected into this opening, and an X-ray plate made, it showed the opening to be the stump of the sigmoid, the rest of the colon being apparently normal. None of the colon below the level of the fourth lumbar vertebra remained. The anus, sphincter muscles, and a short blind pouch of rectum about ten cm. long were discovered on rectal examination. Two plans of operative attack were considered. As first choice, the mobilization of the descending colon and a direct end-to-end anastomosis of the sigmoid to the remnant of the rectum. If this proved not to be practicable, when actually attempted, the possibility was considered of isolating a loop of ileum, and using this as a graft between the sigmoid and rectum, to make good the defect and reestablish the lumen to the anus. Operation was offered on these plans and was accepted.

As the report of this case is not the primary purpose of this paper, only a few further facts will be related concerning it. At operation, it was found possible, by dividing the peritoneum lateral to the descending colon, to mobilize that structure well upward toward the splenic flexure. This permitted the end of the sigmoid to be brought down without tension to the floor of the pelvis. The rectum was opened, and an anastomosis

\* Read before the American Surgical Association, May 13, 1927.

made by invagination of the sigmoid, fastened around a rectal tube, into the rectal stump. After a protracted and stormy convalescence, chiefly due to the patient's mental condition, a complete recovery with practical disappearance of the depression resulted. It required a number of weeks for the sphincter to regain its function, which had not been exercised for four years. Before the descending colon was mobilized, it was seen that a loop of ileum could have been utilized without difficulty, to reach from the sigmoid to the rectum; in fact, a loop of ileum was adherent in the pelvis over the closed stump of the rectum.

Although circumstances had not required the employment of a segment of small bowel to connect the divided ends of the large bowel in this specific

instance, situations in which this procedure might be of the greatest advantage are easily imagined, and it was thought worthwhile to investigate experimentally, the feasibility of such an operation. At that time, although fairly familiar with the general literature of intestinal surgery, the writer had seen no reference to such work having been done.

The plan of operation

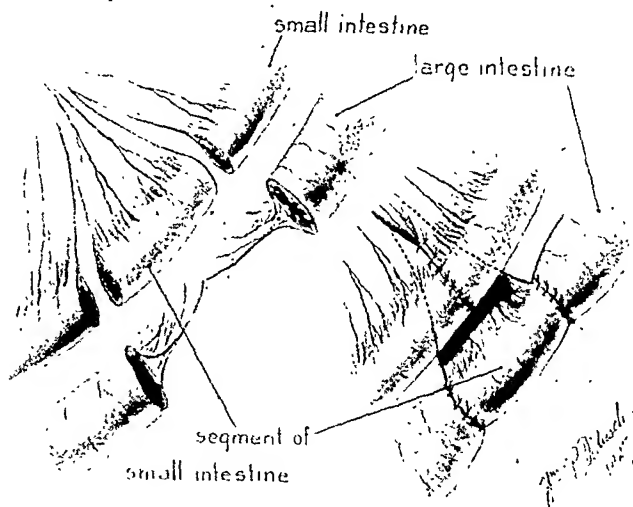


FIG. 1.—Interposition small bowel between ends of divided colon.

adopted was extremely simple. A segment of ileum was isolated by dividing it at each end, being careful to preserve its vascular supply intact. The continuity of the ileum was restored by an end-to-end anastomosis of the bowel above and below the isolated loop. The colon was then divided. The segment of ileum was interposed between the divided ends of colon by two end-to-end anastomoses, care being taken that proximal end of colon was united to proximal end of ileum, and distal to distal ends likewise, so that the intercalated small bowel was arranged iso-peristaltically with the colon. Gaps in the mesentery were sutured as well as possible. (Fig. 1.)

This experiment has been performed on some nineteen dogs, always under ether anæsthesia. The results have been interesting to study. The first two dogs died promptly, one being an anæsthesia accident, the other with extensive peritonitis. As the experiment involved three end-to-end anastomoses and the technic had not been well worked out, these fatalities were not particularly surprising. However, the first seven dogs proceeded to die in uniform succession, none surviving the fourth day. At autopsy several of these animals were found to have imperfect anastomosis, with small leaks and a limited peritonitis—not enough seemingly, to account for such prompt death. The others showed no gross lesion—no peritonitis, no obstruction, no hemorrhage. The transplanted loops were sometimes a little blue and

dusky. The dogs had bowel movements after the operation and they vomited very little.

At this period in the work, the idea was entertained that there must be some physiological incompatibility in the experiment, that prevented its successful accomplishment, and speculation began to arise as to the possible explanation. At the same time, it was appreciated that the experiment was a long one, rather difficult to keep on a plane of technical perfection, that some of the dogs were not in the best condition, and that several different operators were working—all of which might account for the failures. Also it was clearly understood that these were only negative results, and that the survival of one dog would offset all of them, and prove that the operation was possible of success. With the eighth dog, this positive success was attained. The dog was still living after three and a half weeks, and his nutrition and alimentary function were apparently normal. Meanwhile, other experiments have been carried out, and of a total of nineteen dogs, six lived long enough to say definitely that they survived the operation.

In surveying our experiments, we have noted two changes in the detail of operation that crept in almost imperceptibly. The transplanted segment of ileum in the first eight or nine cases was only about five to seven cm. long and its mesentery contained only one principle vein and artery. In the later cases the loops were gradually made longer up to twelve to fifteen cm., and the mesentery was selected to contain at least two sets of vessels. We think these longer loops are better as the anastomoses are not so close together, and there is better circulation. This may account, in part, for the more successful later experiments.

Autopsy on the first successful operation, the dog while still entirely well being sacrificed on the twenty-third day, showed the following: The peritoneum was entirely clean and all three anastomoses were well healed. The ileal anastomosis was adherent near the upper colon anastomosis. The implanted loop was functioning well as shown by the fact that the colon below it was full of fecal contents. The colon above also contained fæces, but the implanted segment itself was empty. Evidently the ileal loop maintained a different peristaltic function from the colon, as it did not retain fecal contents. The colon above the implanted loop was stimulated mechanically while the dog was still alive under ether. A contraction wave passed down to the anastomosis, then stopped, and the implanted loop went into a general contraction, shortening and thickening, but not showing a definite wave. Colon beyond ileal segment then developed a wave contraction. Contents from above segment could easily be milked through it.

After the work just described had been in progress some time, it was learned that in this instance, as has happened so many times before, others had done already, what was believed to be a new thing. The Italian Vignolo † reported in 1912, having done almost the same experiment on animals, for the same reasons that led the present writer to undertake his investigation, and furthermore, announced the successful performance of a very similar operation on a human patient. This man had undergone an extensive resection of the pelvic colon for carcinoma, leaving him in the same con-

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† Vignolo, Q.: Archives générales de chirurgie, Paris, 1912, vol. vi, p. 621.

dition as the patient described in this paper, namely, with a high sigmoid terminal colostomy and a closed blind pouch of rectum below. This had been done April 19, 1910. On August 1, 1910, Vignolo performed what he called an ileo-colo-rectoplasty. He isolated a loop of ileum, about forty cm., above the ileo-cæcal valve, where the mesentery is widest, and reëstablished the ileum above and below this segment by end-to-end suture. Then the upper end of the isolated segment was united to the descending colon by a lateral anastomosis, the terminal colostomy not being disturbed at that time. The distal end of the segment of ileum was passed down into the remaining rectal pouch. From below the mucosa of this rectal pouch was dissected off, and the stump of ileal segment sutured to the anal skin. Recovery from operation was followed by the evacuation of part of the fecal contents through the reconstituted anus and part through colostomy. On fortieth day it was contemplated to close colostomy, but it was then discovered that there were palpable metastases in lower, and further operative work was abandoned.

It will be seen that, except for minor details, Vignolo has anticipated completely the idea and work herewith presented. In his paper he describes his procedure as original, and it is probable that he is the first who has performed such an operation. Furthermore, he has apparently had few, if any, followers. In the volume on Cancer of the Rectum, by Chalièr and Mondor,<sup>‡</sup> published in 1924, the work of Vignolo is extensively referred to, but no subsequent reference is given in an extensive bibliography. Chalièr and Mondor themselves advise the method of mobilization of the descending colon for uniting the sigmoid to the rectum. Soresi,<sup>§</sup> however, has reported similar experiments to those of Vignolo and the writer, and in a personal communication states that he has applied the method clinically.

In summarizing the matter, it may be said that occasionally the extirpation of large parts of the colon, particularly the recto-sigmoid, makes it difficult to unite the separated extremities and so preserve the function of the anus. In certain cases it would be most helpful if the defect thus created could be made good by the substitution of a segment of small bowel, interposed between the divided ends of the colon. The work herewith reported, and the previous work referred to, indicate that such a procedure is feasible, and should be considered when the surgeon is confronted with the problem of colon reconstruction.

The writer wishes to point out that he has not considered the question of how extensive the original attack on the colon should be, and does not wish to give the impression that the possibility of utilizing the rectal stump and preserving a functioning anus, should exert any influence toward preserving these structures when by so doing the completeness and success of the primary operation may be jeopardized.

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<sup>‡</sup> Chalièr et Mondor: *Cancer du Rectum*, Paris, 1924, p. 358.

<sup>§</sup> Soresi, A. L.: *Surg., Gyn. and Obstet.*, 1915, p. 668.

# THE INTERPOSITION OF SMALL BOWEL SEGMENTS

## PROTOCOLS OF EXPERIMENTS

Dog No. 1.—Operation December 16, 1926. Died on third day after operation. Interposed sigmoid was blue and there were leaks at both anastomoses.

Dog. No. 2.—Operation December 21, 1926. Death immediately after operation from fault of the anæsthesia.

Dog No. 3.—Operation December 21, 1926. Died on fourth day, after increasing weakness, but without vomiting. Bowels moved. Autopsy showed no leaks, no obstruction, no peritonitis. Cause of death not clear.

Dog No. 4.—Operation January 7, 1927. Died on fourth day after increasing weakness. No vomiting. Bowels moved, stool normal. At autopsy no obstruction, no peritonitis. Anastomosis intact. Cause of death not clear.

Dog No. 5.—Operation January 14, 1926. Dog was sick from the beginning and died on the second day after operation. No vomiting. Bowels moved. Autopsy showed no obstruction, no peritonitis. Anastomoses were intact and patent.

Dog No. 6.—Operation January 21, 1927. Dog did fairly well for three days. Weaker on third day and died on the fourth. No vomiting, bowels moved. Autopsy showed slight leak at the upper colon anastomosis. Slight peritonitis. No obstruction. Peritonitis not regarded as sufficient to cause death.

Dog No. 7.—This dog on milk and bread diet for four days before operation, to get blood readings. Operation March 4, 1927. On the third day vomited a few times. Bowels had moved well. On the fourth day became weaker and died. Milk and bread diet was continued all along. Autopsy showed slight leak at the colon anastomosis. Very small amount of peritoneal fluid. Do not regard peritonitis as accountable for death. In this case, blood studies were as follows:

	N.P.N.	Total proteins	Cl.
Normal before operation .....	32	7.6	540
On post-operative day—2-24 hrs. ....	45	7.8	500
On post-operative day—3-48 hrs. ....	47	8.0	475

It will be noted that these figures indicate very much the same picture as that seen in intestinal obstruction.

Dog No. 8.—Operation April 12, 1927. Sacrificed on May 5. Dog had been perfectly well until that time. Autopsy showed no peritonitis, no obstruction. Anastomoses perfect and the segment of interposed bowel functioning.

Dog No. 9.—Operation April 16, died April 19. Small leak at ileal anastomosis with limited peritonitis. Loop of gut strangulated through opening in mesentery.

Dog No. 10.—Operation April 19, 1927. Still living and well. Bowels moving normally.

Dog. No. 11.—Died on fourth day with general peritonitis.

Dog No. 12.—Died on fourth day with general peritonitis.

Dog No. 13.—Operation April 25, 1927. Still living and well.

Dog No. 14.—Operation April 26, 1927. Died on fourth day. Had leaks at upper colon anastomoses with general peritonitis.

Dog No. 15.—Operation April 29. Still living and well.

Dog No. 16.—Operation May 3, 1927. Died on May 6. Autopsy showed secondary obstruction and perforation at one of the anastomoses.

Dog No. 17.—Operation April 20, 1927. Still living and well.

Dog No. 18.—Operation April 29, 1927. Still living and well.

Dog. No. 19.—Operation May 3, 1927. Still living and well.

I wish to acknowledge the great assistance given me in the execution of this experimental work by Drs. Edward James, F. C. Lee, Thomas R. Chambers, William Noble and Arthur H. Hebb.

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# FISTULÆ OF THE SMALL AND LARGE INTESTINE\*

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NO SEGMENT of the alimentary canal between the duodenum and the anal orifice is immune to the development of fistulæ. This paper, however, is restricted to the consideration of fistulæ above the level of the rectum, in which location fistulæ which are very common, present an interesting chapter of surgery that has never perhaps received the attention it deserved.

Intestinal fistulæ may be conveniently divided into two large groups: (a) one, the more frequent, in which the fistula opens externally on some part of the abdominal wall, and (b) in which, in the absence of such an opening, the fistula connects the lumina of two or more hollow viscera. Theoretically a third variety is possible, in which the fistulous tract is a persistent channel through which the contents of a contiguous abscess have previously discharged into a hollow viscus. In this last-mentioned process nature has usually proved efficient not only in selecting an advantageous exit for the purulent material, but in promptly healing both the abscess cavity and the fistulous tract as well.

Fistulæ connecting two or more hollow viscera may either cause characteristic symptoms or their existence may be revealed only when the abdominal cavity is explored. The not infrequent fistulous formation between the stomach and large intestine from the extension of the ulceration of a gastro-enterostomy orifice, or less frequently from the extension of a destructive malignant process, is followed by the eructation and regurgitation of the colonic contents that have passed into the stomach, and usually by progressive emaciation, due to the passage of an insufficient quantity of stomach contents directly into the lower segment of the alimentary canal. On the other hand, nature's effort to relieve unusual biliary obstruction by the discharge of the contents of the gall-bladder directly through a fistulous communication into the contiguous duodenum affords at least temporary relief, while the presence of the fistulous tract, although it may be suspected, cannot be actually demonstrated until the radical cure of the cholelithiasis is undertaken.

Fistulæ that open externally usually present the unmistakable discharge of the contents of that segment of the intestine, in which their inner orifice is situated. The quantity of this discharge depends upon the length of the fistulous tract, the degree, if any, of its tortuosity, and the size of the inner orifice. In one instance observed by the writer, a fistula following an operation for an abscess connected with the appendix, was so small that only an occasional puff of gas escaped at intervals through an opening, into which only a slender probe could be inserted for a short distance. After five weeks

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\* Read before the New York Surgical Society, April 13, 1927.



this fistulous tract closed spontaneously. It is also quite possible for the discharge, either of gas alone, or of gas mixed with intestinal contents, to be intermittent, with periods of several weeks' duration in which the outer orifice presents the appearance of an ordinary sinus. In one instance of this type following an operation for the relief of a pelvic abscess, bismuth injected into the sinus prior to the discharge of either gas or intestinal contents, was found by an immediate X-ray to have passed into the intestine, from which it was subsequently discharged through the rectum. In this case the inner orifice was in the beginning valvular, and allowed the entrance of extraneous material under pressure but not, for a time at least, the exit of intestinal contents.

All of these fistulæ have a longer or shorter intervening tract between the hollow viscus and the skin. When this tract is absent and the visceral mucous membrane and the skin are continuous, the discharge of intestinal contents in a quantity which varies directly with the size of the orifice is inevitable.

The location and size of fistulæ of the duodenum and colon are ordinarily indicated by the character and quantity of the discharge. More precise information of the location of the inner orifice and the character of the fistulous canal can be obtained by an X-ray following a bismuth meal or a bismuth enema. In the small intestine, however, this method is obviously impracticable and the location of the inner orifice can be roughly estimated only by the length of time elapsing between the administration of an aniline dye in the food and its appearance in the discharge.

While intestinal fistulæ usually develop spontaneously in connection with some abdominal lesion, a much smaller number are intentionally established by the surgeon for the relief of intestinal obstruction, including the condition of intestinal paresis due to septic peritonitis. In other cases, as after the closure of an acute perforating gastric or duodenal ulcer, a jejunostomy is done by some surgeons to place the sutured area at rest and to provide for the introduction of fluids and nourishment. Fistulæ done under such circumstances frequently save life, and usually close spontaneously after they have served their purpose. Exceptionally they persist, and if the opening is in the upper part of the intestine and if it discharges the major portion of the intestinal contents, its closure, especially in the weakened condition of the patient, may be both serious and difficult.

A knowledge of the etiology of fistulæ that develop spontaneously frequently leads to their successful prophylaxis. They are likely to follow the impairment of the circulation of any part of the intestinal canal. Such a circulatory disturbance may develop in the duodenum in the course of the removal of a gall-bladder, especially when numerous and firm adhesions make anatomical identification difficult. In the early days of kidney surgery fistulæ of the duodenum occasionally followed a right lumbar nephrectomy or nephrotomy. In tubercular or malignant involvement of one or more of the abdominal contents the circulation of the affected intestine may be so curtailed as to favor fistulous formation. Thus after a laparotomy for a tuber-

cular peritonitis, or after the exploration of inoperable malignant growths, fistulæ occasionally develop in the abdominal incision notwithstanding the fact that it had been completely closed without drainage. In cases of the sudden complete exclusion of the circulation of an intestinal loop as in strangulated hernia, the formation of a fistula is nature's method of relieving the obstruction. The writer recalls such a case when an interne in the service of the late Doctor Bull at the New York Hospital, in which the entire contents of the small intestine were discharged through a fistulous opening. As conservative measures failed to check the discharge, and as no operation was undertaken for its relief, the patient gradually succumbed to a slow starvation. In the present state of efficient abdominal surgery, some radical measures would doubtless be attempted in a desperate condition of this character. Probably localized infection, resulting in abscess in close proximity to some intestinal loop, is the most frequent cause of fistulæ when the purulent material is not promptly evacuated by the surgeon. Thus localized abscesses resulting from slowly perforating ulcers on either side of the pyloric ring, the much more common abscesses due to an infected appendix, in which surgical relief is unduly delayed, and the long-standing abscesses from tubal infection in the pelvis predispose to fistulæ of the duodenum, the cæcum and lower ileum, and the sigmoid, respectively. In these cases of neglected suppuration, the post-operative development of one or more fistulæ may usually be foretold, and much trouble and anxiety may be averted by informing some responsible member of the patient's family of the possibility of the development of that complication.

It is quite obvious that careful dissection and separation of the gall-bladder and of the right kidney in operations on these organs, the delicate and gentle handling of the intestine in all laparotomies, the prompt relief of all strangulated herniæ, and the early evacuation of the pus in abdominal infection will effectively diminish the frequency of the development of intestinal fistulæ. Furthermore, in all abdominal conditions in which post-operative drainage is necessary, the greatest care should be exercised to prevent the contact of drainage material with any visceral line of suture. Furthermore, a drain should be selected which is free from rigidity in order that any unnecessary pressure upon the wall of some adjacent hollow viscus may be avoided. The daily change of the drain and its permanent removal at the earliest possible moment is greatly to be desired.

A variety of abdominal fistula in which the cause still remains unsolved and in which consequently no certain prophylactic measures have been devised is the gastro-colic fistula which occasionally follows the extension of a persistent or recurrent marginal ulceration of a gastro-enterostomy orifice. This fortunately infrequent complication occurs after gastro-enterostomies carried out in accordance with the most approved methods by surgeons of the greatest skill and experience. The persistent irritation of non-absorbable sutures in the approximation of the divided mucosæ is probably a predisposing cause and should be avoided. Recently an enthusiastic surgeon

in the Middle West, using a silk suture in this step of the operation, sought the approval of a much older and experienced colleague who dryly remarked, "That he had taken out a good many sutures, in patients in whom continued bleeding after operation indicated the persistence of ulceration," without unfortunately convincing the operator of the error of his way. It is scarcely necessary to add that the undue persistence of such marginal ulceration justifies operative revision of the site of the gastro-enterostomy before the colon becomes involved.

Apart from the observation of suitable prophylaxis, the treatment of fistula is either conservative or radical. Conservative measures are invariably indicated except in those fistulæ in the upper part of the alimentary canal, in which starvation is threatened by the discharge of a considerable portion of the intestinal contents. For example, in duodenal fistula, if the discharge of intestinal contents is so small (and this is not infrequently the case) that the patient receives adequate nourishment, operation is contra-indicated. If the discharge is, or becomes abundant, some measure must be promptly undertaken to check it while the condition of the patient still permits. On the other hand, the discharge of the entire intestinal contents through the fistulous orifice in the lower part of the small intestine or colon does not usually affect the general nutrition of the patient and radical treatment is justified only when, in spite of conservative measures continued for weeks or even months, the fistula persists.

The irritating effect of the discharge on the skin adjacent to the fistulous orifice is controlled, although not always successfully, by the application of suitable emollients and by the frequent change of the dressing, while an effort is made to minimize the discharge by the pressure of graduated tampons. Good results have followed the use of tampons impregnated with oil, especially in duodenal fistula in which the fistulous tract is narrow and tortuous.

Fecal fistulæ following the removal of an infected appendix are much less frequent if the stump of the ligated appendix is buried by a purse-string suture of absorbable material. This precaution is mentioned in view of the fact that only recently its omission was noticed in the operating room of one of the active hospitals of this city. When the gangrenous process involves the contiguous wall of the cæcum as well as the appendix, the friability of the necrotic tissue makes the infolding of the appendix stump much more difficult if not impossible and the subsequent development of a fecal fistula is almost inevitable. Notwithstanding the probability of the development of this complication, it is wiser not to attempt to avert it by the excision of the necrotic area with closure of the defect, but it is preferable by suture of the omentum to and over the suspicious area to endeavor to delay the formation of the threatened fistula until adhesions have shut off the general peritoneal cavity, a precaution which usually seems to diminish the size of the fistula and to shorten the period of its closure. Rarely in the opening of long-standing abscesses a necrotic segment of the intestinal wall may be evacuated with the pus, exposing a bridge of mucous membrane along the mesenteric

border between the upper and lower segments. If the condition of the patient permits, the affected small intestine should be excised with end-to-end anastomosis. In one such instance the post-operative drainage of the abscess cavity did not prevent primary union of the anastomosis. While a non-infected operative field is desirable, it is interesting to note that it is not essential to the proper conduct of intestinal repair.

The writer does not recall a fecal fistula following operation for an infected appendix that failed to close spontaneously provided that the appendix was removed and a purse-string suture applied to the ligated stump. In several cases in which the appendix was not removed, a small persistent fistula communicating with the cavity of the appendix was readily cured by the removal of the offending organ. It goes without saying that such experience extending over many years of active hospital practice is exceptional and that unquestionably some fistulæ of this group leading into the cæcum or lower ileum or both, which persist in spite of long-continued conservative treatment, can be permanently cured only by some form of operation.

Fistulæ connected with some part of the ascending, transverse, or descending colon are uncommon. On the other hand, the prevalence of pelvic abscess resulting from appendix or tubal infection, or to the threatened or actual perforation of a diverticulum, accounts for the relative frequency of fistulæ of the pelvic sigmoid. In the treatment of this variety conservatism is, if anything, more urgently indicated than in fistulæ of the cæcum for the prognosis of spontaneous closure is just as favorable and in the event of radical interference, the great depth of the fistulous orifice, the presence of baffling adhesions, and the frequent tortuosity of the fistulous tract make the operation both hazardous and difficult. It is particularly in this location that, as the fistulous orifice becomes narrowed, the retention of the discharge may lead to the development of one or more secondary abscesses of which drainage is necessary.

The condition of the patient in fistulæ of the duodenum or upper part of the small intestine in which the larger part of the intestinal contents are discharged through the fistulous orifice, does not ordinarily permit an operation of any magnitude or duration. For example, while a gastro-enterostomy, combined with a division and suture of the pylorus, might be expected to close such a fistula, the patient would probably succumb to the operation. Even in the less extensive operation required to expose and suture a fistula lower down in the small intestine, the ultimate outcome might easily be questionable. On this account some attempt should be made to reëstablish the normal passage of the intestinal current in all cases in which no distal cause of obstruction exists by the following procedure advocated by Koehler (*Zeit. für Chirurgie*, 1925, vol. lxxiv, pp. 1886, 2655), which has the unquestioned merit of simplicity and of being capable of application without unduly taxing the patient's greatly lowered vitality. The measure referred to consists in the introduction of the horizontal portion of

a "T" tube of flexible rubber through the fistulous orifice into the lumen of the intestine, the longer and shorter segments lying, respectively, above and below the site of the fistulous orifice. The projecting vertical portion of the "T" passes through the opening. Peristaltic activity keeps the intra-intestinal tube in close contact with the intestinal wall and by thus closing the inner orifice of the fistula, permits the restoration of the normal current of intestinal contents. Various modifications of this measure may be utilized. Thus a rubber tube of which a gutter has been made seems to fulfil the indications of the horizontal portion of the "T." Another important modification consists in utilizing a "T" tube of which the horizontal portion is double, the additional segment being in close contact with the external abdominal wall. The vertical portion of the "T," connected with both horizontal segments, permits their approximation, the resulting pressure effectively closing the fistulous tract. The hollow vertical portion of the "T" tube, ordinarily closed by a clamp, serves for the introduction of fluids and nourishment at suitable intervals. When granulation has materially reduced the size of the fistulous orifice, the vertical and outer horizontal segments of the "T" tube can be easily severed, leaving the remaining horizontal segment within the intestine to be discharged through the rectum. This method is especially applicable in the treatment of intestinal fistulæ in which the affected loop can be readily approximated to the external abdominal wall, a type of fistula moreover, in which the discharge of intestinal contents is most likely to be excessive.

Radical treatment is indicated in intractable fistulæ in which conservative measures have failed. Either the simple extra-peritoneal suture of the orifice of the fistula may be attempted or the more formidable suture or resection. The former measure was much more frequently employed in pre-antiseptic days in view of its comparative freedom from risk. Because of its frequent failure to afford relief, it has been gradually superseded by the more radical intra-peritoneal attack of which the danger has been greatly diminished by improved surgical technic and skill. Detailed description of the radical treatment of fistulæ is unnecessary. Only the fact should be emphasized that, in resection of the affected loop, the continuity of the intestinal canal should be effected with the least possible sacrifice of normal intestine.

In conclusion the writer wishes to refer to the treatment of complete fistulæ of the lower part of the small intestine in which the distal segment of the intestine, retracted into the peritoneal cavity, lies at some distance from the anterior abdominal wall. Such extensive necrosis of an intestinal loop is a rare complication of an infected appendix. In one such instance observed by the writer, it had followed the mere incision of an abscess by a skilled and experienced colleague, the operation being restricted to that measure because of the desperate condition of the patient. The possibility of immediate repair in favorable cases of this character by end-to-end anastomosis has already been mentioned, a case being cited, in which a most satisfactory result was obtained.

The same treatment, indicated as a secondary measure when the primary operation has been limited to the drainage of the abscess cavity, is much facilitated by the temporary suture of both the proximal and distal intestinal orifices in the angles of the wound, if these openings can be readily recognized. As, however, intestinal necrosis is rarely apparent at the time of the primary operation and the fistula does not develop until several days afterward, the orifice of the distal loop is usually deeply seated and its identification, possible only after entering the peritoneal cavity, is very difficult owing to its collapsed condition and the presence of adhesions. When this condition exists the writer wishes to emphasize the following technic, of which the object is to facilitate the identification of the distal orifice with the least degree of intra-peritoneal manipulation and consequently with the least amount of soiling of the operative field.

The first step of the operation consists in the isolation of the proximal loop and its mesentery until the vertebral attachment of the latter structure is reached. After following this attachment a short distance downward and to the right, careful dissection is carried forward, keeping close to the mesenteric layer, until the orifice of the distal loop comes into view. Further adhesions between intestinal loops both above and below the exposed orifices can then be readily separated and an end-to-end anastomosis easily done.

Finally the comparative safety of the intra-peritoneal operation in a field necessarily contaminated by intestinal contents should be emphasized. While such a condition forbids the closure of the wound without drainage and may lead to infection of the abdominal wall, the repair of the sutured hollow viscera is usually complete or complicated only by slight temporary fistulous formation. The pre-antiseptic apprehension of the danger of this operation no longer obtains.

# EPIGASTRIC HERNIA IN ITS RELATION TO INTRA-ABDOMINAL DISEASE\*

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THE problems involved in our diagnostic methods have always given the clinician, and the surgeon as well, great concern. The gastric crisis of syphilis has often been confused with perforating gastric ulcer, appendicitis with pneumonia and cholecystitis diagnosed where the thyroid gland was the offending organ. Patients, not infrequently, have made the rounds of the general practitioner, the gastro-enterologist, or even the surgeon, and a thorough hospital examination revealed a small epigastric hernia. Our incentive for this brief paper, first had its inception at the Mayo Clinic several months back. A patient was elsewhere told that he was suffering from a gastric ulcer. While his chief complaint was gastro-intestinal, yet a small epigastric hernia was responsible for the production of symptoms. We have had occasion since then to observe several very interesting cases of epigastric hernia. The recognition that the symptomatology as evidenced in epigastric hernia mimics gastro-intestinal disease will assuredly be conducive to a greater number of diagnoses of this condition.

## CASE HISTORIES

CASE I.—A male, age thirty-nine, white, presented himself with the complaint of intermittent pain referred to the epigastrium. There was nothing of import in the family or personal history. His symptoms were all referable to the gastro-intestinal tract. There was marked hunger. Pain was relieved by taking food but recurred a few hours later. A loss of weight of about twenty pounds in a year was noted. He first experienced pain a year ago, when he consulted a physician. He had had gastro-intestinal series and gall-bladder visualization. The diagnosis at that time was cholecystitis. The patient was a well-developed and nourished male. Head, ears and nose were negative. Eyes: pupils equal and regular, reacting normally to light and distance. No jaundice. Lungs and heart normal. Abdominal examination revealed sharp localized tenderness in region midway between umbilicus and xiphoid. There was marked spasm of the recti-muscles. No gall-bladder tenderness. While no hernia was detected in the patient when in recumbent position, yet on standing and asked to cough, a small mass was elicited in the midline about two inches above umbilicus. The patient was sent to the operating room and the hernia repaired. At the same time all intra-abdominal organs were examined, no pathology being found. An incidental appendectomy was done. Laboratory findings: Urine, negative; red blood-cells, 3,904,000; hæmoglobin, 80 per cent.; white blood-cells, 6200; 60 per cent. polyneutrophile. Wassermann and gastric

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\* Read before the New England Section of the American College of Surgeons, February 28, 1927.

analysis negative. Patient made an uneventful recovery and was discharged. There was no recurrence of symptoms.

CASE II.—A female, age fifty-six, white, came under our observation with a train of symptoms pointing to gastro-intestinal involvement. She complained of a fulness after meals, belching and sourness. Distress worse at night, tending to ease toward morning. Could eat only certain foods, and avoided the so-called heavy foods. During the year she had lost about sixty pounds. She had been to several physicians, had undergone X-ray series, gastric analysis and stool examination. The diagnosis in her case was that of gastric ulcer or gastric carcinoma. She had been on a milk and cream régime. General physical examination showed nothing of importance. She was an obese woman and careful palpation brought out a hernial mass in the midline above the umbilicus. The patient stated that she too noticed a bulging mass especially when on her feet for several hours. This patient was sent to the operating room and an abdominal exploratory as well as repair of the hernia was done. No pathology was found in the course of the visceral examination. Laboratory findings were essentially negative. Patient made an uneventful recovery, being discharged with no recurrence of symptoms.

CASE III.—A female, age forty-five, white, presents herself complaining of a sharp pain in the epigastrium. This patient had undergone two abdominal operations for the relief of this pain, which a midline and McBurney scar corroborate. X-ray series, gastric analysis, blood Wassermann had been previously done. The pain complained of was constant, there being no relation to intake of food. Relief was forthcoming in the recumbent position. It is interesting to note that she had been on several dietary regimens. The clinical picture is that of a woman who has been in pain. The physical examination is essentially negative. The abdomen shows the telltale scars of previous operations, a per primam healed McBurney and midline incisions. The patient was examined in the upright posture. Marked tenderness was elicited at a point in the epigastrium midway between umbilicus and the xiphoid process. There were no bulging masses. In the midline corresponding to this point of tenderness, a small mass, size of a ten-cent piece was palpable which was exaggerated by coughing. The palpating finger encountered a crepitus sensation. There was increased pain as well. This pain and mass disappeared when patient was permitted to lie down. The diagnosis in this case was epigastric hernia and surgical intervention advised.

*Etiology.*—It is therefore not at all surprising that Ferrier in 1885, advanced the belief that many of the indefinite and vague histories of persistent pain and discomfort localized to the upper quadrant may find their underlying etiology in an undetected epigastric hernia. Epigastric hernia *per se* while not uncommon, yet finds its incidence about 2 per cent. as compared to other types of hernia. If we recall the anatomy of the region where epigastric hernia occurs, we find (a) That the recti-muscles are separated by a greater space above the umbilicus than below. (b) That the linea alba is merely a joining of the fibres of both anterior and posterior sheaths of the recti-muscles. (c) That the vessels of the falciform ligament perforate the transversalis fascia and linea alba.<sup>1</sup> One can readily see how a point of potential weakness is established at this perforation of vessels through the transversalis fascia. Increasing intra-abdominal pressure, after a tab of fat has found its way to this potential weak point, would bring on an enlargement, at the same time pushing the peritoneum ahead of it and the consequent hernial sac. When epigastric hernia does result it is found between the xiphoid and umbilicus. We must not overlook a congenital gap in the transversalis fascia as a causative factor. Quain<sup>2</sup> has divided epigastric hernia



into two types: (a) Peritoneal lipoma without a sac. (b) True hernia with a sac. We would, however, suggest that the type is dependent upon the duration of the condition. The first if let go long enough eventually goes into the second type.

*Symptomatology.*—The symptoms as are related by patients suffering from epigastric hernia unless one is acquainted with the condition are easily misleading. There is a history of antecedent painful indigestion, some in relation to meals, others have no association. The pain varies with the type of food ingested. Nausea, vomiting, belching of gas and sourness are complained of. Examination will elicit tenderness in the epigastrium and in the gall-bladder area. Referred pains to the shoulder blades and back have been offered. One might suggest that the pain and its relation to taking of food, and lack of periodicity would easily differentiate epigastric hernia from typical ulcer or gall-bladder or carcinoma histories. But if we consider that where organic lesions of the gastro-intestinal tract have been found, less than 50 per cent. of these cases give the so-called text-book picture. In a series of 100 cases examined at the Mayo Clinic where gastric ulcer was found at operation, 35 cases gave a so-called typical history, 31 a fair history, 29 a vague history, 4 mixed, 1 gall-bladder history. Our problem thus becomes real and is deserving of our best efforts.

*Diagnosis.*—Peculiarly enough it is the small hernia, the size of a pea, that gives the most trouble and symptoms simulating gastric ulcer, carcinoma, duodenal ulcer and gall-bladder. The large ones, on the other hand, are not so easily overlooked and lend themselves to an early diagnosis. Inspection and palpation of the linea alba with the patient in standing posture is of paramount importance. The palpable sensation suggesting "surgical crepitus" is encountered. Coughing or stooping over tends to bring the hernia to our attention. The history focussed toward the presence of a bulging mass should be stressed. Hæmatemesis, blood in the fæces, gastric dilatation usually point to an organic intestinal lesion. Epigastric hernia and gastric ulcer, as well as carcinoma and duodenal ulcer, have coexisted. Danon<sup>3</sup> reports several such cases. Gastric analysis offers us no solution. The X-ray examination in skilled hands is of great importance and organic lesions are easily determined. The referred pains which we encounter in this condition are somewhat clarified if we appreciate the underlying anatomy. The lower intercostal nerves perforate the opening in the linea alba and anastomose with the sympathetic nerves following the blood-vessels of the falciform ligament and in this way a relationship with the phrenic nerve is established. This would explain the vomiting and other gall-bladder symptoms. Further, there is an anastomosis set up with the splanchnic nerves which would account for the gastric syndrome occurring in epigastric hernia. The stimulus is derived from a pinching of these nerves at the small hernial opening. Some investigators have even advanced the theory that tugging or pulling on the omentum, as is often found in epigastric hernia, might be causal in the production of gastric ulcer. But Ivy<sup>4</sup> and Meyer, of Chicago, have sutured the omentum

to the sheath of the rectus muscle in 14 dogs, thus bringing about tugging of stomach by omentum. In no single case was there an ulcer found, though pouching of the pyloric portion of stomach was in evidence in six dogs. These findings strongly oppose the theory that epigastric hernia is a causative factor in the production of gastric ulcer.

*Treatment.*—Surgery is of course the treatment of choice. The operation performed is usually that as advocated by W. Mayo for umbilical hernia. Moschcowitz prefers the vertical incision and a suture placed above and below. Whichever method is employed, it is advisable to explore the intra-abdominal organs, particularly where gastro-intestinal involvement is suggested. Careful follow-up after these patients leave the hospital is essential.

#### CONCLUSIONS

1. Epigastric hernia may be overlooked unless we bear the condition in mind in its relation to upper intra-abdominal disease.
2. The small hernia gives the more striking symptoms.
3. Attention to gastro-intestinal series, Wassermann and other laboratory findings.
4. Surgery is indicated and an abdominal exploratory advisable in all suggested cases.

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# NOTES ON THE COLLATERAL CIRCULATION IN BLOOD-VESSEL DISEASES OF THE LOWER EXTREMITIES

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ONE of the most remarkable phenomena in the human body is the manner in which the main arterial channels of a limb may become totally occluded without the part becoming gangrenous. It is a slow process, and a well-recognized one clinically, and when it occurs it is generally understood that the collateral circulation, so-called, has taken the place of the main arterial channels. In fact, the phenomenon is of such frequent occurrence—especially in the lower limbs—that we speak of the collateral circulation quite glibly; so much so, that one would think its channels were as well charted and as well known almost as are the main channels.

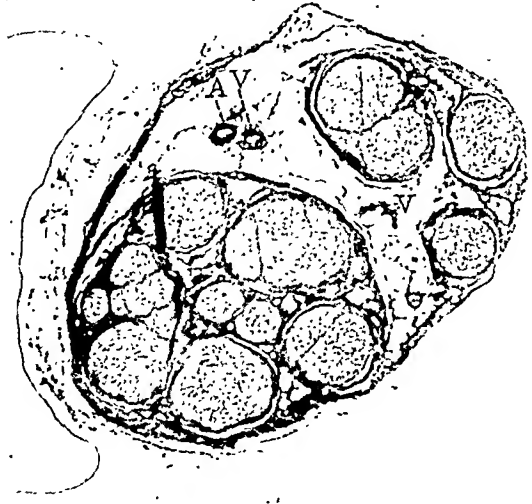


FIG. 1.—Case No. 2947.

Nothing of the sort is true. On the contrary, there is a decided ambiguity on the subject. An ambiguity that, more than likely, has arisen by reason

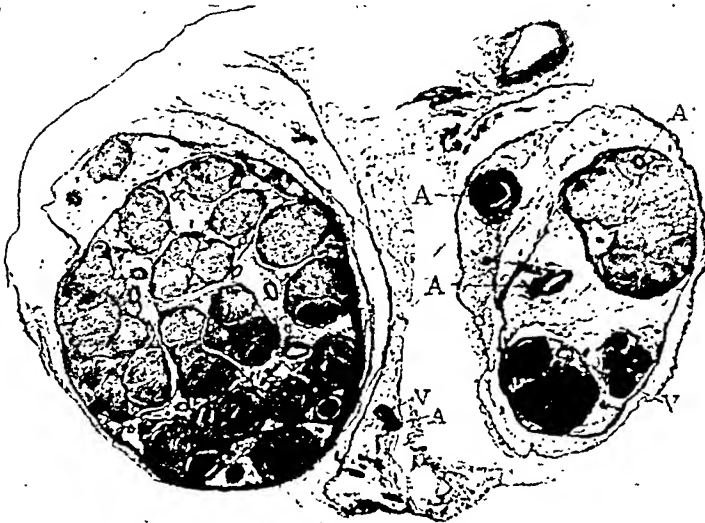


FIG. 2a.—Case No. 2852.

of the fact that collateral blood channels are not stressed by the anatomists and the need for accurate knowledge on the subject has never seemed necessary to the operating surgeon since he has always felt that little or nothing could be done about it one way or the other. If he ligated a femoral artery, it has been his feeling that there might

be a collateral circulation adequate to the needs of the situation or there might not, but that, other than ligating the accompanying vein to balance, in a way, the circulatory pressure in the limb and then wrapping the member

in cotton and keeping it warm generally and elevating it, there was nothing further for him to do; the matter was entirely out of his hands.



FIG. 2b.—Case No. 2852.

In a vague sort of way it has been felt that if the femoral artery were tied off below the profunda this latter vessel would be the main blood feeder to the leg. If the ligation were above the point at which this vessel comes off, then the gluteal arteries were to be in some way the source of supply. In any case, the whole thing was an indefinite sort of an affair and being in

great part more a matter of chance than anything else, accurate knowledge in the premises was not needed and therefore was not sought.

Our own interest in the subject arose by reason of the studies we have been carrying on in regard to the threatened and real gangrenes that are produced by thrombotic and other processes. It is not so difficult to understand how the profunda artery can sustain a leg, but it is difficult to see how the gluteals can do it alone. Or at least it was difficult until we looked the matter up and found that they do it—or one might better say the inferior gluteal artery does it by way of the little arterial branches it gives off as it comes out of the pelvis *to the sciatic nerve*.

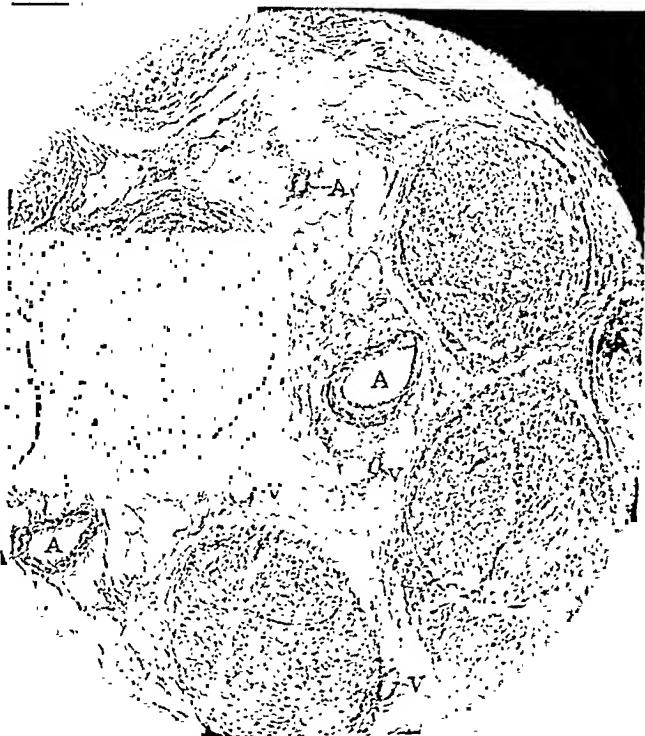


FIG. 2c.—Case No. 2852.

These arterial branches are normally quite small and insignificant, so small, that in amputating a limb for accidental injury—gunshot, etc., the sciatic

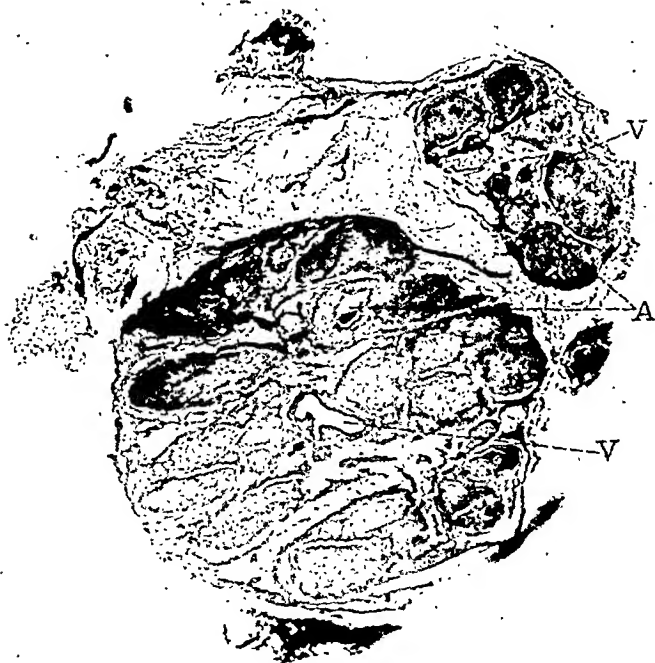


FIG. 3a.—Case No. 3225.

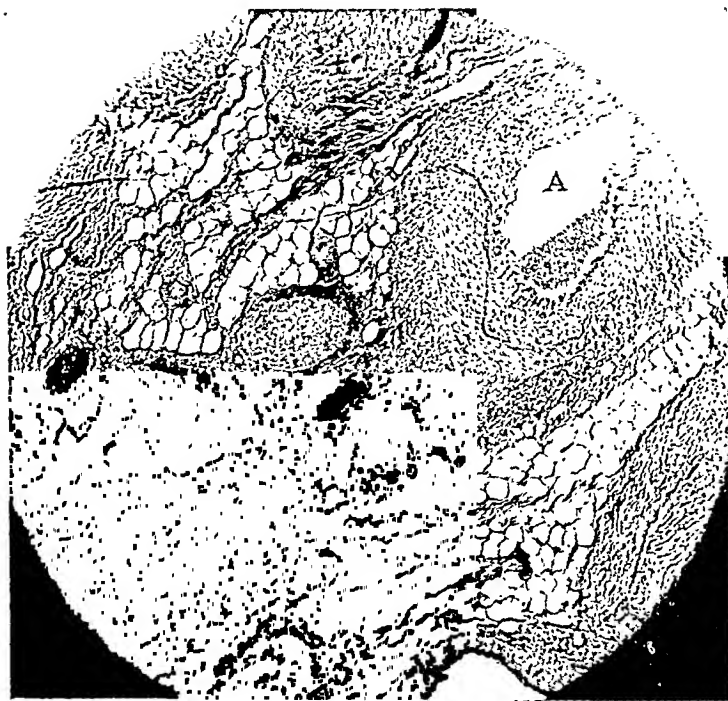


FIG. 3b.—No. 3225.

vessels are of such relative unimportance that one hardly has to ligate them. In the thigh amputations that are done for gangrene consequent upon profound arterial disease, however, the sciatic arteries are uniformly found to be increased in number and in calibre. They are about the only pulsating vessels found and require very careful ligation. Having their origin higher up than the thrombotic process usually rises in the arterial tree, they offer a direct line of blood flow to the tissues of the lower leg and foot. At times we have even thought their pulsation could be felt. In any case, their presence, their increase in size and calibre explains without any ambiguity the survival of a limb whose every normal channel may be completely occluded.\*

In order, however, to determine just how much of an increased vascularization takes place in and around

the sciatic nerve of the gangrenes and the manner in which it is accomplished, we secured several autopsy specimens from normal limbs for comparison. All specimens, whether of the normal or of the pathological, were taken just below the mid-thigh, the reason for this being that this is the usual site of election in amputations done for vascular disease. At this point the sciatic nerve trunk is usually divided into a larger and smaller branch, the two branches being separated by loose connective tissue. The trunks in turn are divided by firmer connective tissue into funiculi. There is usually a moderate-sized vessel in each trunk, proportionate to its size. There may be a variation in that the blood-vessels may be present in the connective tissue between the trunks. It is interesting to note that vessels are not visible within the nerve tissue of the normal funiculus. This is in accordance with what histologists say, namely, that the endoneurium which consists of fibrous tissue between the nerve fibres, serves to conduct among them *relatively few capillary* blood-vessels which are supplied to the interior of each funiculus.



FIG. 4b.—Case No. 2917.

Figure 1 shows such a picture, No. 2947, age fifteen. This patient died of cerebral hemorrhage due to haemophilia. The sciatic nerve has a blood supply that appears to be proportionate to the size of the nerve trunk and is quite the normal thing. It consists of a moderate-sized vessel and several veins. This vessel happens to be in the connective

\* Bernheim, Bertram M.: The Significance of the Blood-pressure in Circulatory Disorders of the Extremities.

## COLLATERAL CIRCULATION IN LOWER EXTREMITIES

tissue between the trunks. A small vessel can be seen in an interfunicular septum. No vessels are made out within the funiculi themselves.

Figure 2-A, No. 16—No. 2852, age sixty-one—Sinai Hospital—History No. S 6085—diabetes mellitus—arteriosclerosis. This section was obtained at amputation for gangrene of the leg, therefore, according to the conception of collateral circulation advanced in this paper, the sciatic nerve should have shown, and does show, a marked increased vascularization as compared to the section shown above. Attention is called to the large and small arteries at "A" and the veins at "V."

Figure 2-B, taken 2 cm. lower than the above sections, shows this even more clearly.

Figure 2-C is a higher magnification of 2-B, giving a close up on the several vessels and funiculi. The vessels are numerous and the walls well developed. An occasional arteriole is seen within the funiculus.

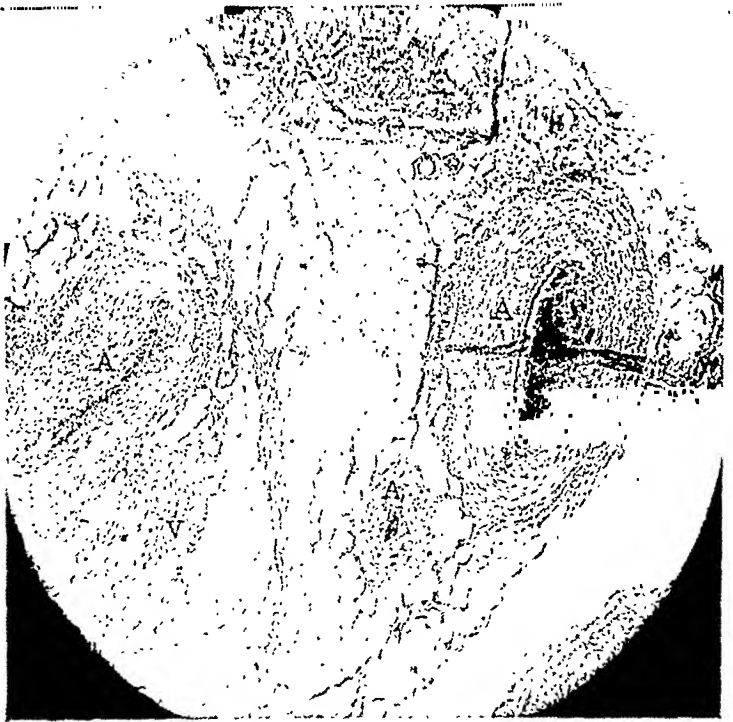


FIG. 4c.—Case No. 2917.

Figure 3-A, No. 3225, male, age sixty-four—Sinai Hospital—History No. S 7599—arteriosclerosis. This section was obtained at amputation for gangrene. The nerve trunk is bifurcated, each branch having a large artery which is out of proportion to the size of the trunk. There are several smaller arteries present. The venous supply is also correspondingly large. There are several moderate-sized and small vessels present within the funiculi.

Figure 3-B is a higher magnification of 3-A, showing the arterial and venous walls and also smaller vessels.

Figure 4-A, No. 2917, male, age eighty-five—Sinai Hospital. History No. S 6538.

Thrombo-angietis obliterans. This section was obtained at amputation for gangrene. The nerve trunk is bifurcated. The greater bulk of the nerve tissue makes up the larger trunk, the smaller consisting of five small funiculi. The large trunk has an unusually large artery and several smaller ones. The smaller trunk has a tremendous artery and vein—also several smaller vessels.

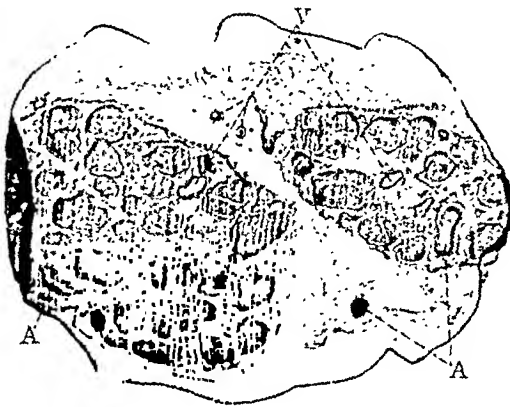


FIG. 5a.—Case No. 2944.

Figure 4-B, taken 2½ cm. lower than 4-A, shows further division of the sciatic nerve, and smaller amount of nerve tissue (one funiculus). The artery accompanying the latter, however, is comparatively

tremendous and it is seen further from the main branch, apparently leaving the nerve trunk.

Figure 4-C is a higher magnification, showing the full development of the vessel

walls. This section shows the smaller vessels in the interfunicular septa, in the perifunicular connective tissue and within the funiculi.

Fig. 5, No. 2944, Sinai Hospital, J. F., male, age sixty-four. The nerve trunk is bifurcated. There is a large artery and vein in each trunk, which are out of proportion to the amount of nerve tissue. In addition, there are considerable-sized arteries and veins present between the trunks.

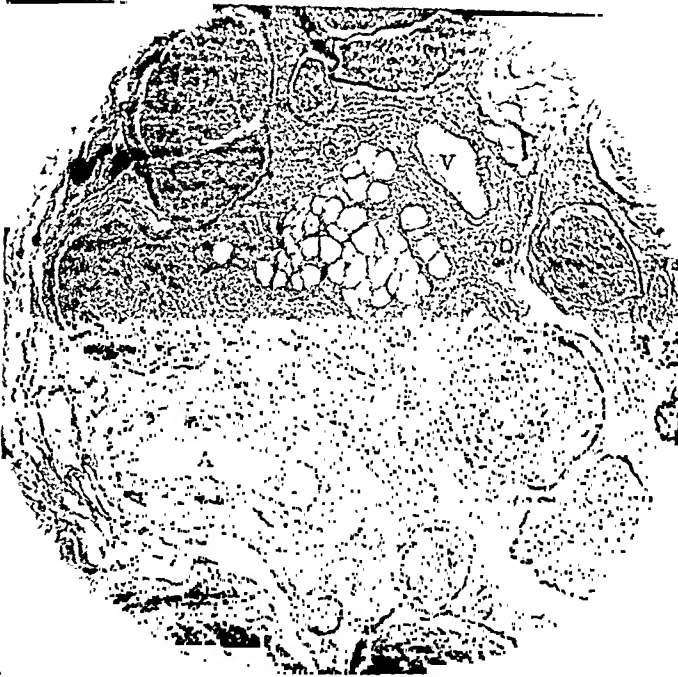


FIG. 5b.—Case No. 2944.

Figure 5-B is a higher magnification of the vessels in the lesser trunk, showing the development of the vessel walls.

Figure 6-A, No. 2759, Sinai Hospital, History No. S 6632—thrombo-angitis obliterans, male, age forty-three. This section was obtained at amputation, just at the bifurcation of the sciatic nerve. There are two moderate-sized arteries and very many smaller-sized vessels. This section differs from the preceding ones, in that the increased vasculari-

zation is distributed in many smaller vessels rather than a few larger ones. It shows also very extensive increase in vascularization within the funiculi. There are numerous arterioles and venules present in the latter as shown in sections 6-B and 6-C.

Figure 7-A, J. R., History No. G. U. 348. This section was obtained at autopsy. Several months before the death of this patient, from embolism in the coronary artery, he recovered from a threatened gangrene following trauma to the big toe of the same limb from which this nerve trunk was later taken. At that time he had no pulsation below the femoral vessels.

The fact that his recovery was complete, shows that his collateral circulation was well established and enough to carry on sufficient circulation. This section shows a huge artery and two accompanying veins, in addition to smaller well-developed vessels. The processes which caused occlusion of the popliteal and lower vessels is present in this large artery, i.e., calcification of the walls and even bone formation. It is safe to say that this vessel played a great, if not the greatest part, in maintaining an adequate circulation for his limb.



FIG. 6a.—Case No. 2759.

Figure 7-B is a higher magnification of a portion of section 7-A. Within the funiculi there are several well-developed arterioles and venules. Though this finding is



COLLATERAL CIRCULATION IN LOWER EXTREMITIES

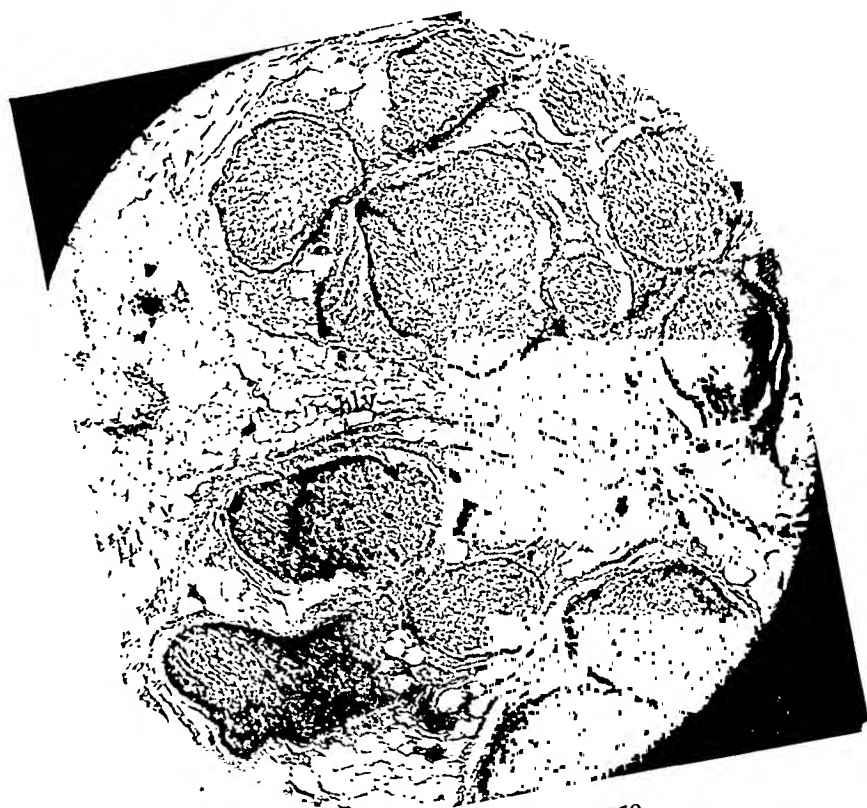


FIG. 6b.—Case No. 2759.

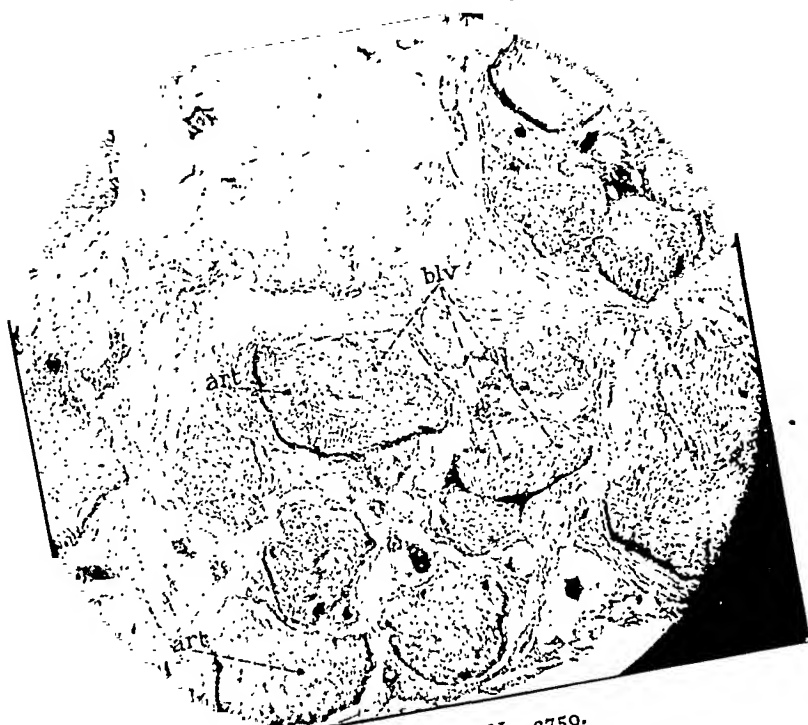


FIG. 6c.—Case No. 2759.

constant in all the preceding cases, they occur in greater profusion in this one. The greater number is undoubtedly indicative of more extensive development and efficiency of collateral circulation.

# SUMMARY

(1) The normal sciatic nerve trunk has moderate-sized vessels, generally a proportionate-sized vessel for each division. There is an absence of blood-

vessels, arterioles and venules within the nerve tissue of the funiculus. Only capillaries are present and these are not visible at ordinary magnification.

(2) In obstructive vascular disease of the limb, such as arteriosclerosis, thrombo-angitis obliterans, etc., examination of the sciatic nerve

reveals a definite increase in the number and size of the blood-vessels, both in perineural tissue and within the funiculi as well. These findings are constant.

(3) This increased vascularization accounts for the survival of certain limbs long after their main blood channels have become totally occluded.

(4) Knowledge of of this increased sciatic nerve vascularization is of importance in amputating gangrenous limbs.

Finally attention is called to the rather startling fact that whatever the disease process that has affected (and obstructed) the main blood channels may be, the sciatic vessels are *not* similarly involved other than by a thickening of their walls and by some calcification as noted in section 7-A. Thrombosis of the sciatic vessels has not been noted in our experience.



FIG. 7a.—Case No. 2928.

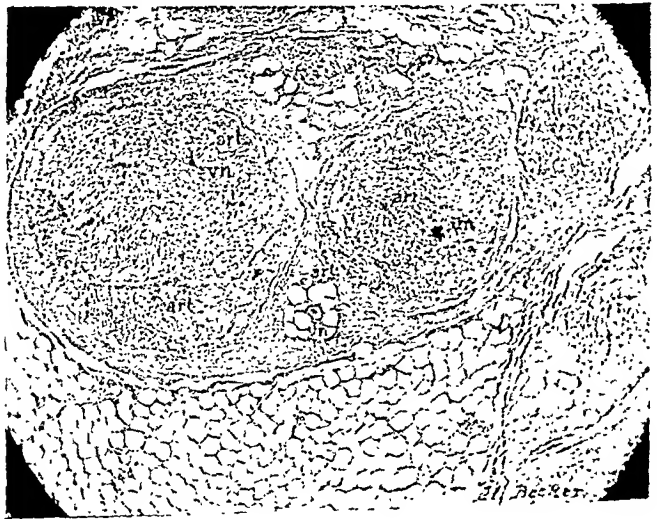


FIG. 7b.—Case No. 2928.

# LIGATION OF THE FEMORAL ARTERY BELOW THE ORIGIN OF THE PROFUNDA FEMORIS IN THE TREATMENT OF OBLITERATIVE ENDARTERITIS OF THE LEG

LEWIS AND REICHERT OPERATION

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LIGATION of the femoral artery below the origin of the profunda femoris in the treatment of obliterative endarteritis (thrombo-angiitis obliterans) of the leg was first done by Dean Lewis, of the Johns Hopkins Hospital. The operation was described in an article by Doctor Lewis and Doctor Reichert in a recent issue of the *Journal of the American Medical Association*.<sup>1</sup>

The idea that this operation might be beneficial was suggested to Doctor Lewis by the statement in an article by Meleney and Miller<sup>2</sup> published in 1924, that they had been able to show an extensive collateral circulation in legs which had been amputated because of gangrene due to a vascular lesion similar in every way to obliterative endarteritis. Meleney and Miller injected the vessels of these amputated legs with bismuth oxychloride and then made röntgenograms of them. These röntgenograms showed in a striking way the constant establishment of an extensive collateral circulation, involving the smaller vessels especially. Doctor Lewis thereupon conceived the idea that the collateral circulation in the leg could be utilized and made to function more extensively in obliterative endarteritis.

The surgeon usually sees obliterative endarteritis late in the disease, when gangrene has already set in, and what he treats is really only a complication of a definite, generalized disease process. The atheromatous changes in the distal vessels develop slowly as a result of toxæmia from various types of chronic infection or as a result of prolonged irritation of the intima by abnormal products



FIG. 1.—Condition of foot at date of operation. Note destruction of tissue over joint of great toe. October 25, 1926.

of metabolism in excess in the circulation. The breaking down of the inner coat of the distal arterioles and infiltration with connective tissue gradually closes the lumen of the vessels, cuts off the blood supply and results in dry gangrene. When occlusion of the blood-vessels and interference with the blood supply sets in, Nature promptly begins to utilize the collateral circulation, and a race, as it were, is on between the occlusion of certain blood-vessels on the one hand and development of other blood-vessels



FIG. 2.—Note line of demarkation with normal granulation tissue. Tendon being covered. December 1, 1926.



FIG. 3.—Collateral circulation in the foot seen after injection of the popliteal artery in case of thrombo-angiitis obliterans.

in the collateral circulation on the other. Occlusion as a result of this disease progresses slowly, and the development of blood-vessels connected with the collateral circulation also takes place slowly. The result depends upon which process outstrips the other. Whether death of the part involved is to take place depends upon whether the rate of development of the condition causing an inadequate blood supply exceeds the rate of development of the collateral circulation, and this depends largely upon the potential capacity of the individual to develop a collateral circulation. Establishment of an equilibrium between the two processes means an adequate blood supply and life of the part; failure of the collateral circulation means an inadequate blood supply and death of the part, or gangrene.

## OBLITERATIVE ENDARTERITIS OF THE LEG

Doctors Lewis and Reichert reasoned that ligation of the femoral artery below the origin of the profunda femoris would both inhibit the rate of occlusion of the diseased vessels on the one hand and stimulate the development of the collateral circulation on the other, and the results of his operation apparently justify these conclusions. The anatomy, physiology and pathology of the condition involved stamp the operation as a most rational procedure.

Amputation in the dark, without sufficient knowledge of where to amputate, was formerly the rule. Amputation in itself is easy to do, but to decide where to amputate in order to obtain the best result is not easy. Amputations above, below and through the knee have all been recommended, and each has been thought to be preferable to the other two. Modern surgeons prefer to amputate as low as possible, but ignorance of the location of the place in the blood-vessels where the circulation is obstructed is the chief obstacle and determination of this important point is difficult. Several years ago, Dr. Wm. R. McKinley, of Columbus, Miss.,<sup>3</sup> proposed that the diseased vessels be dissected upward until a point was reached where the blood supply appeared to be satisfactory and that amputation be done at this point. But the difficulties attending this procedure are almost too great to justify attempting it.

In treating these cases it should be the aim to save as much of the limb as possible. The blood supply must be maintained, and a definite line of demarcation must be established before amputation in order to obtain this object.

At first thought, ligation of the femoral artery seems to be quite a radical procedure, and many surgeons will hesitate before attempting it. But the profunda femoris is a large vessel, and, bearing in mind the extent to which collateral circulation can and will develop, the anastomotic possibilities of the profunda femoris as it passes down the back of the thigh and leg, are unusually great. This is well shown in the accompanying photograph of a röntgenogram of an injected leg. (Fig. 1.)



FIG. 4.—Collateral circulation in the leg and foot in case of thrombo-angiitis obliterans. Gangrene of toes occurred. A recent thrombus was found in the popliteal artery. This had to be removed before injection was made. It seems probable that the gangrene was coincident with the extent of the thrombus into the popliteal artery.

Ligation of the femoral artery below the origin of the profunda femoris in the case reported herewith caused no inconvenience and resulted in great improvement in the condition of the diseased leg in a remarkably short time. Healthy granulations developed in the affected area, the gangrene ceased to extend and was beginning to recede, and the foot was beginning to assume a healthier appearance, as may be seen in the accompanying photographs, but, unfortunately, thirty-six days after the operation the patient died suddenly as a result, apparently, of pulmonary embolism. Autopsy was refused.

CASE.—J. M., a white male, age fifty-nine, an American of Irish extraction, a messenger in the War Department, was admitted to Garfield Memorial Hospital, October 14, 1926, complaining of pain in the left foot, and of cough with expectoration of much thick, tenacious mucus. He had been subject to "colds" in the winter time, with dyspnoea and cough, and the expectoration of much thick muco-purulent material, and had been told that he had bronchial asthma. There was a tendency to constipation, but no other digestive disturbance. He had to rise at night about three times to urinate, but had no other genito-urinary symptoms, denied venereal disease, and otherwise had had no especial illness, no surgical operation or accident. He was abstemious, his habits were good, and his ordinary bodily functions were normal. There was no tendency to chronic illness in his family connection.

For the past three or four years he had had recurrent attacks of pain and cramps in the legs, below the knee. This pain was sharp and severe, came on suddenly and stopped suddenly. October 1, 1926, he noticed small water blisters on the left great toe. Next day the foot was so painful that he remained in bed, and he had been practically confined to bed ever since. A few days after the appearance of the blister, the toes became dusky in color, then purplish-blue, and the foot felt as if pins were sticking in it.

Examination showed him to be a rather poorly nourished, elderly, white male, with slight dyspnoea, sclerosis of the accessible vessel walls, slight opacity of both lenses, no teeth, slightly hypertrophied heart, the signs of a moderate degree of emphysema and chronic bronchitis, slight enlargement of the liver, varicose veins in both legs, marked hardening of the walls of the femorals and popliteal arteries, a faint pulsation in the posterior tibial arteries, absence of pulsation in the dorsalis pedis, and necrosis of the distal phalanges of the five toes on the left, especially marked in the left great toe. (Fig. 2.) There was no sensory disturbance, but on hanging the feet over the side of the bed the left foot became purplish-red and very painful. The blood-pressure was practically normal, the systolic pressure being 148, and the diastolic 80. An X-ray examination of the feet showed no abnormality of the bones. There was no anemia or evidence of blood dyscrasia. The blood Wassermann reaction was negative. The fasting blood sugar was normal, 102 mgms. per 100 c.c. of blood. The urine contained a small quantity of albumin but was otherwise normal.

October 25, the left femoral artery was tied just proximal to Hunter's canal. There was no shock, and recovery from the operation was uneventful. From this time to December 1 the appearance of the foot indicated steady improvement in the circulation and subsidence of the gangrene. This is well shown in the accompanying photographs. No local treatment was employed for the first three weeks. Then the foot was soaked daily in hot water. The patient was allowed to be up in a chair and was beginning to get around, but the foot was still painful, so that he occasionally had to have codeine. December 1 he complained of a sense of fullness in the chest, and said that he had noticed this fullness for several days. His temperature was normal and there had been nothing else unusual in his condition. Half an hour later he became much worse, complained of severe pain in the chest, became dyspnoeic and cyanotic, and suddenly expired.

## OBLITERATIVE ENDARTERITIS OF THE LEG

It was impossible to secure permission for an autopsy, but the diseased foot was obtained. (Fig. 3.)

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# CIRCULATORY FACTORS INFLUENCING NORMAL OSTEOGENESIS

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RECENT investigations tend to show that malignant growth takes place in an almost anaërobic medium (Warburg<sup>1</sup>); or at least under the influence of a retarded circulation (Burrows<sup>2</sup>). Burrows, even postulates that all forms of biological growth depend on overcrowding of cells and a slowing of the blood flow.

The process of calcification of bone seemed to offer an excellent oppor-



FIG. 1.—Röntgenograms of rat, ventral surface down. The resected bone on the right side has been completely replaced with solid bony union, but on the left there is a wide space still present where no calcification is evident.

tunity to study the changes occurring under different artificially induced circulatory conditions. The amount of calcification could be followed from time to time by Röntgenograms, thus giving a graphic record of the growth changes.

*Procedure.*—Experiments were first undertaken on the albino rat. The fibula in this animal is solidly fused with the tibia above and below and bows outward in between the fixed points. It is thus possible to have the tibia maintain ideal splinting conditions for any experimental work such as simple fractures or resection of a portion of the fibula. Various methods of interfering with the venous circulation of the limb were attempted, such as application of a tourniquet, pressure, etc., but there were so many technical difficulties that a standard experiment as described below was adopted.

One-half centimetre of the mid-portion of the fibula was removed symmetrically on each leg under ether anaesthesia, aseptic technic being used. No attempt was made to preserve the periosteum. The right leg was then kept as



## CIRCULATORY FACTORS INFLUENCING OSTEOGENESIS

the control and the saphenous vein identified, ligated and divided in the left leg. Healing took place per primam in every instance. Röntgenograms were

taken from time to time to follow the progress of healing. (Fig. 1.) The bone gradually filled in and united in the control leg in six weeks, but no union took place in the leg which had the venous system partially blocked, although the space between the bone ends lessened in amount. The result was uniform in a small series of rats

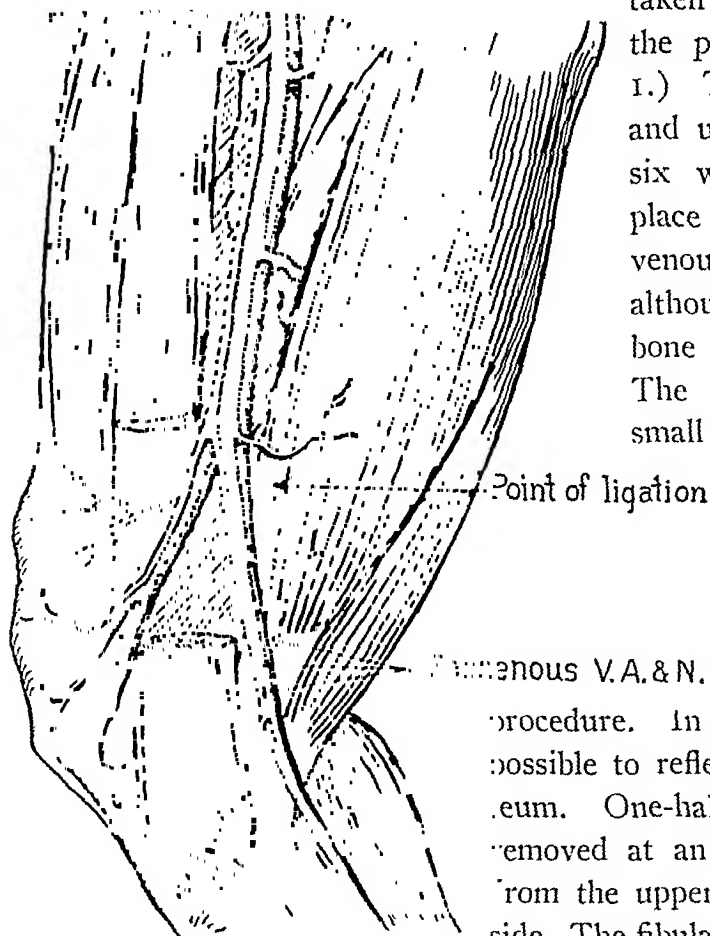


FIG. 2.—The circulation of dog's leg, indicating point of ligation in these experiments.

It was decided to transfer the same conditions of experiment to larger animals and accordingly dogs were selected and submitted to the same procedure. In this case, however, it was possible to reflect and preserve the periosteum. One-half centimetre of bone was removed at an equally measured distance from the upper end of the fibula on each side. The fibula in the dog is closely applied to the tibia in the lower half of the leg and

then bows outward as a separate bone to reach the knee-joint level. The saphenous system enters in the lower third of the dog's leg and is accompanied by an artery.<sup>3</sup> The saphenous vein was ligated on the left leg and divided.

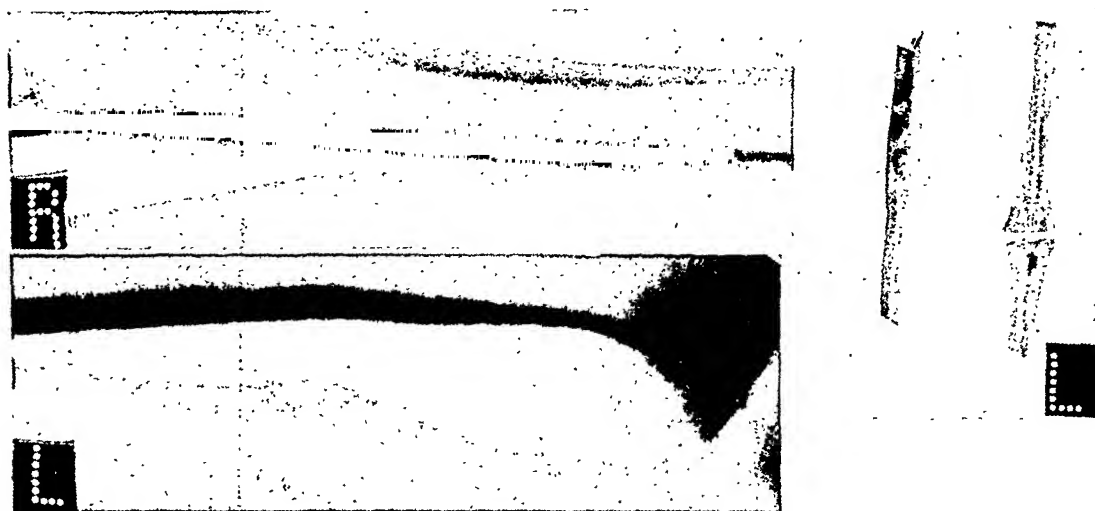
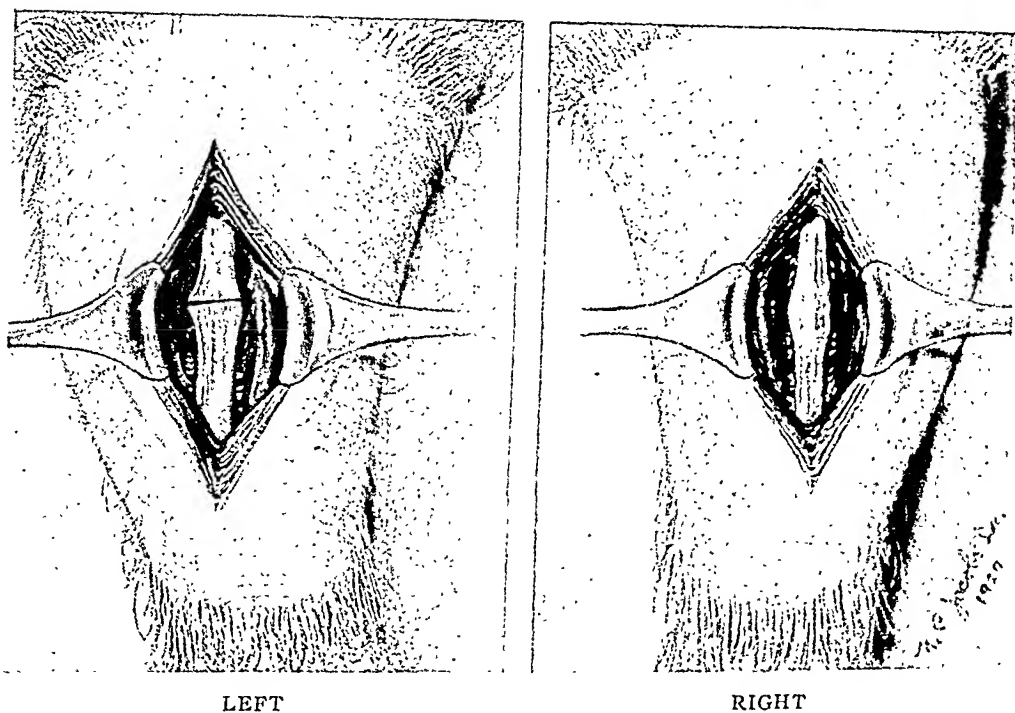
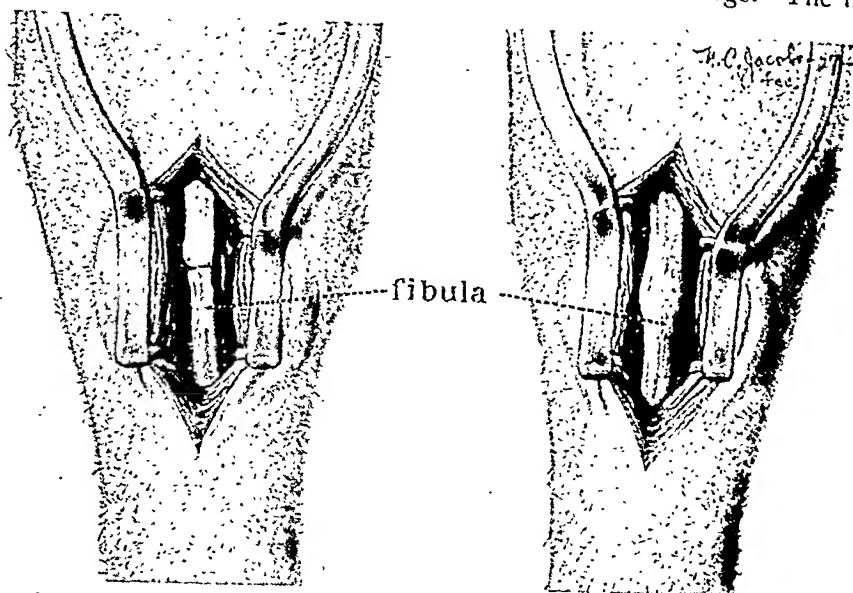


FIG. 3.—Dog No. 26=78, X-ray taken January 7, 1927. The right side shows almost complete union. The left side shows a gap still present. Bones removed February 2, 1927 and X-rayed, show complete union on right and non-union on left.

(Fig. 2.) Röntgenograms were again used as a check for the amount of callus formation. After nine weeks the control leg had healed solidly in every case, but the leg with the partially blocked venous system had failed to unite. (Fig. 3.) The result was uniform in a series of three dogs. The bone was



LEFT

RIGHT

FIG. 4.—Condition of the resected bones in Dogs Nos. 26=70 and 26=78 as seen at exploratory operation. Complete union on the right and non-union on the left.

explored and specimens removed for study in two of these cases. Drawings show the gross comparison between the normal and the control sides. (Fig. 4.) Dog 26-70; 26-78.

Microscopic sections were also made and whereas the control leg shows osteogenesis taking place in a normal manner the experimental side shows

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very little calcium deposit, but consists mainly of cartilage and a small amount of osteoid tissue. There was nothing abnormal about this picture except that it had not advanced as far as on the control side. (Fig. 5.) Dog 26-78.

In a similar type experiment, simple fractures were made in two dogs

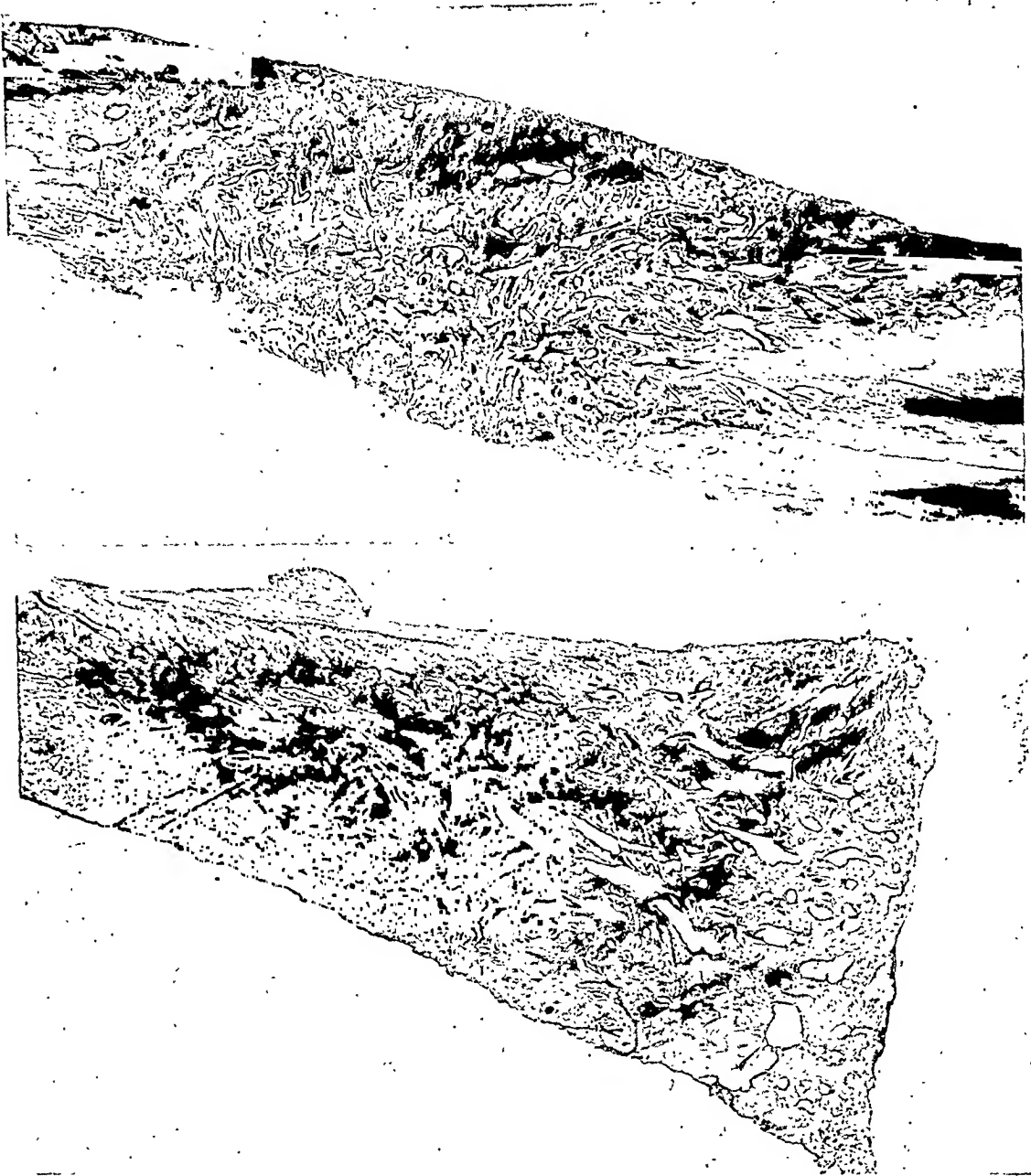
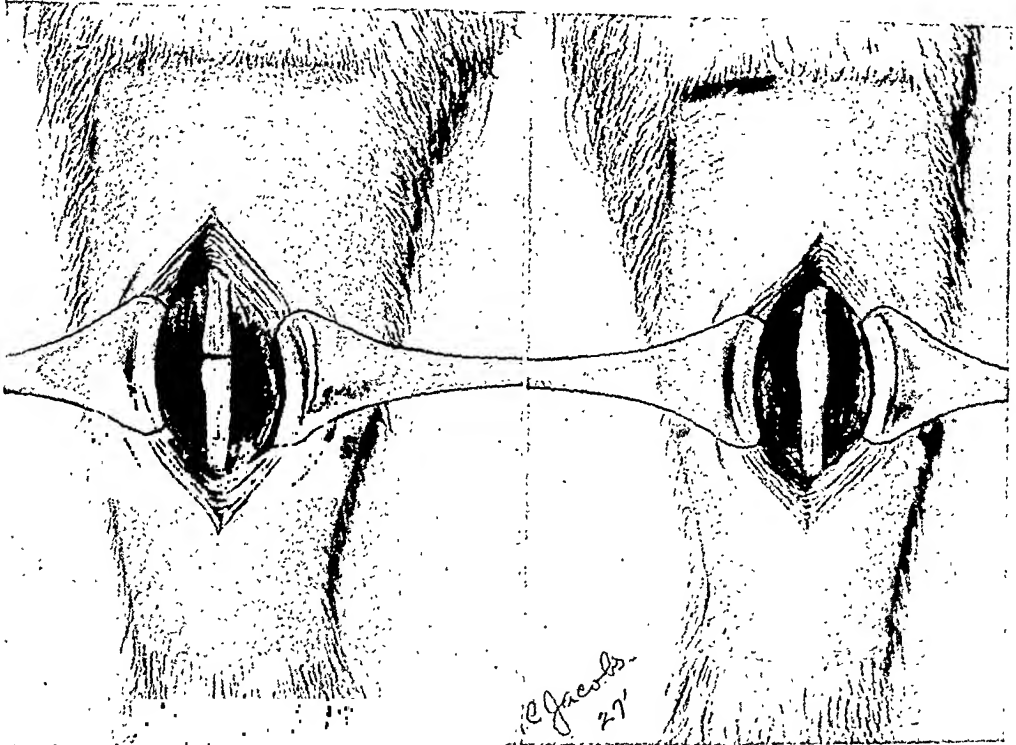


FIG. 5.—Dog No. 26-78. The upper microphotograph shows complete bony union between the bone ends. There is no cartilage or osteoid tissue present in the section, ( $\times 15$ .) The lower microphotograph shows the end of one of the non-united bones. There is a narrow terminal zone of cartilage and osteoid tissue and patches of calcification throughout the section. The difference between this and the upper section is one of degree only. The bones were decalcified for cutting, ( $\times 15$ .)

and no union took place on the experimented side, although the control side healed in seven weeks. One of these non-united fractures was explored and removed for study. A drawing shows the condition of the bones on removal. (Fig. 6.) Dog 26-90. *Discussion.*—Although the series is small, the result is so constant that it is assumed to be uniform under similar conditions.

Aside from a very slight amount of oedema which lasts for about one day on the experimented side, there is no outward sign of any disturbance. The temperature of the feet seems to be the same on palpation, although no delicate check has yet been made on this point. The outcome of the experimental ligation of part of the venous return was entirely different from the anticipated result. Whether the delay in osteogenesis is due primarily to a disturbance in the nutritional relations in thus altering the blood flow; or whether local changes in the chemical reaction are responsible, must be



LEFT

POSTERIOR VIEW

RIGHT

FIG. 6.—The bone as it appeared on exploratory operation following a simple fracture, complete healing on right and non-union on left.

determined by further work which is now in progress. There are a number of reports already in the literature which would tend to support the latter hypothesis.<sup>4, 5, 6</sup> These experiments might have a bearing on the problem of delayed or non-union of fractures. It is possible that tearing or thrombosis of a part of the venous flow from the injured member in such cases determines the velocity of the repair of the bone. It might be necessary also to take into consideration the influence of pressure from splints or casts on the venous circulation.

*Summary.*—When a resection or fracture of a portion of the fibula is made in the white rat or dog, union takes place after a certain period of time. If in addition to the above experiment under exactly the same conditions, the saphenous vein is divided, bony union is delayed beyond the normal repair period. Whether union ever takes place or when it takes place must be left for further observations.

*Conclusions.*—A partial block of the veins of a limb in which there is a fracture seems to cause delay in the union of the fracture. The same holds for a resection. As yet no explanation of this phenomenon is apparent.

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# ANASTOMOSIS OF PORTAL VEIN WITH INFERIOR VENA CAVA\*

A THOROUGHLY TESTED AND SATISFACTORY  
METHOD OF MAKING AN ECK FISTULA

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*Review of the Literature.*—It is just fifty years since N. V. Eck first described his method of anastomosing the portal vein with the inferior vena cava. This method has undergone numerous modifications, involving all of the methods employed in the anastomosis of tubular structures. The persistence of this difficult procedure has depended on its importance in the investigation of problems of the physiology of the liver. The true Eck fistula comprises not only the anastomosis of these two large veins, but the ligation of the portal vein close to the liver, and well above any of the portal collaterals. The so-called reverse Eck fistula implies the ligation of the vena cava above the anastomosis, so that the systemic circulation from the abdomen and lower extremities passes through the liver before entering the heart. This variation has found its use in complete removal of the liver, since, by shunting the systemic blood through the portal system, the collaterals around the liver are established by the increased pressure in the portal vascular system, and hence a new pathway is made to serve after the liver has been removed. A certain number of the more practical methods, which cover the general principles involved in all, will be reviewed here.

Eck placed two rows of sutures for the anastomosis, leaving the last suture untied until after he had cut the window between the rows in the walls of the veins. The size of the window was limited by the length of the points of his scissors. Stolnikov modified this procedure by soldering guide wires and needles to the points of his scissors, so that the blades might be placed without tearing the veins. Pawlow and Nencki employed this method, soldering silver wires to the tips of the scissor-blades but found that the instrument failed frequently at critical times because the needles came off the guide wires or the wires became detached from the scissors. Italian investigators found copper wires to be more satisfactory than silver. Interrupted silk sutures were employed.

This scissor method was further refined by Bernheim, Homans and Voegtlin in 1909, and by Bernheim and Voegtlin in 1912. They used two rows of continuous sutures, and filled the gap through which the scissors were inserted with a mattress suture which was not tied until after the connecting lumen was cut. They devised special scissors, with a bent shank and a guard to make the insertion easier and to keep the instrument in line while it was being placed for cutting.

Queriolo employed a rigid tube to connect the portal vein and inferior vena cava. This technic was improved by von Karltreu, but he obtained poor results at best, and experienced the same difficulties that had confronted Queriolo: distortion of the blood channels and traction on the pancreaticoduodenal vein.

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Tansini implanted the cut end of the portal vein into the vena cava, between clamps, making an end-to-side anastomosis. Perroncito used this method and found it satisfactory on the whole, but it caused too much distortion and traction on the vessels involved.

Sweet adopted a method which required a small wire cautery. The anterior layer of sutures was placed and the cautery wires guided into position on silk sutures. After the anterior row of the suture line had been placed the cautery was turned on and a lumen burned out, after which the wires were withdrawn. The chief objection to this method is the uncertainty of action of the cautery.

Mention should be made, in connection with the methods involving clamps, of the one brought forward by Jeger, who employed small metal clamps modelled after curved gastro-enterostomy clamps. The procedure, once these clamps were in place, was the same as in performing gastro-enterostomy. Horsley devised clamps of a similar nature which have been used in the lateral anastomosing of vessels.

Fischler and Schroeder were the first to offer the method which employed a cutting suture. After placing one row of interrupted sutures, they introduced a heavy silk suture through both veins; this was sawed out after the anterior suture line of the anastomosis had been placed. The procedure was modified by Mann, who employed continuous sutures of fine silk instead of the interrupted sutures. Mann also introduced the "S" incision which greatly simplified the technical difficulties by securing good exposure. Fischler adopted this incision in his last description of his technic.

Bird devised an ingenious method which depended on a hæmostatic stitch, which everted small pleats in both the vessels to be anastomosed. The tops of these pleats were trimmed off and the anterior suture line placed in position. The hæmostatic suture was then removed with the result that the window dropped down into position.

All of the scissor methods are open to serious objections: there is danger either of cutting out the suture lines or of cutting the wall of either of the veins. Moreover, the size of the lumen so cut was necessarily limited to the length of the blade of the scissors. The direct end-to-side anastomosing and the implanting of a tube produce too much distortion and traction to permit satisfactory circulation. All methods in which interrupted sutures are employed are slow, and the danger of hemorrhage is greater since more manipulation within the abdominal cavity is necessary than with continuous sutures. The principal objection to Sweet's method is its extreme slowness. Bird reported that several of his dogs died because the stoma was not open. In the method described here, the window may be made any size desired, up to 4 cm. in length. Speed is gained by the use of continuous sutures and the "S" incision which gives wide exposure to the field. There is no greater risk of hemorrhage than from any other method, and the inherent simplicity of the procedure reduces this to a minimum.

*Technic.—Animals.*—This operation may be performed on dogs of any size, but it has been found advantageous to select animals weighing from 15 to 18 kg., of either sex (females preferred). Short-haired dogs with flat, broad chests are usually chosen.

*Instruments.*—No special instruments are required besides those necessary for blood-vessel suturing. All instruments may be placed in one pan at the beginning of the operation. The blood-vessel suture material is sterilized in mineral oil by boiling it on an electric plate. All other materials are sterilized in the usual manner. These materials comprise the usual instruments for opening and closing the abdomen, including a ligature carrier, an abdominal retractor, and a blood-vessel suturing outfit. This outfit contains three mosquito forceps and one Rankin m. j. straight hæmostat without teeth which is used as a needle holder. The suture material consists of (1) No. 0 silk,

threaded double, 40 cm. long, on a No. 12 Phoenix needle (Harper's), which has been cut down in length to from 1.5 to 1.7 cm. and resharpended. Two of these sutures are required, one for the anterior row and one for the posterior, and (2) No. D, buttonhole twist for the cutting suture; it is used double and threaded on a "milliner's" No. 8 needle (Roberts parabola). This needle is about 4.4 cm. long. Its tip is bent into an arc for its terminal 1 cm.

*Preparation.*—The animal is fasted for twenty-four hours prior to operation, but water is never withdrawn. The abdomen is shaved well over to the right side. After the dog is anæsthetized (ether anæsthesia) the skin is cleansed with benzine, and two coatings of iodine (2 per cent. in ether). The animal is first anæsthetized in a large chamber and then placed on the table when an intratracheal tube is inserted. This tube is connected with a can of ether having an opening at its top, so that the animal breathes over the surface of the ether. This has been found to be a satisfactory method of anæsthetizing; it is simple and the animal requires little or no watching.

*Incision.*—The animal is draped in the routine manner, with towels and sheet; room is left to the right and downward. The incision is started at the xiphoid, carried downward in the median line for from 5 to 7 cm. and then diagonally to the right across the abdomen, just below and parallel to the right costal margin for about 10 cm.; then it is carried directly downward for from 12 to 15 cm., depending on the size of the dog. This gives excellent exposure. The muscles and fascia are cut through together, and bleeding points caught in clamps. The preperitoneal fat is divided high near the xiphoid, since this keeps it out of the field without further difficulty as soon as the abdominal retractor is slipped into position.

*Operation.*—Once the abdomen is opened, and the intestines are properly placed, the assistant gently holds the portal vein in place, as directed by the operator. It is essential that he does not allow slipping or movement, since this generally starts small hemorrhages from the hole of the suture which is then being placed. The assistant must not try to sponge. Frequently it has been found that all the necessary retraction can be done satisfactorily with one hand; this is preferred because it affords the operator more room to work in the abdominal cavity. The assistant places the tip of his gloved finger over any small points which may ooze as this is the quickest and surest way of stopping oozing. The traction is somewhat complicated, being dorsal and caudal; at the same time the tips of the fingers keep the portal vein close to the vena cava, removing all tension from the suture lines. The various stages in the operation are as follows:

1. The fat and connective tissue around the portal vein is freed by blunt dissection for from 5 to 6 cm. The vena cava is usually sufficiently free of fat to make any preparation of this vessel unnecessary. With the help of an aneurism needle, a ligature is placed beneath the portal vein, high and close to the liver, above the entrance of the pancreaticoduodenal vein. The ends of this ligature are clamped and laid outside the abdomen and not tied until the last step before closing the abdomen.

2. The cephalic stay suture is placed; first a bite of about 1 mm. is taken in the portal vein, and then the suture eased through for about half its length. Then the suture is carried through a corresponding point in the vena cava; while the assistant pushes the two vessels together, the operator ties the ends, and having put a mosquito clamp on the tied ends, lays them outside the abdominal cavity. The assistant must not let up at this stage, or a small tear in the portal vein may result with some oozing of blood. Then the caudal stay suture is placed, about 4 or 5 cm. further caudally along the course of these two vessels. Again, it is placed through the portal vein first and then through the vena cava, and tied gently while the assistant keeps the two veins in close proximity. A mosquito clamp is attached to the short end and laid outside the wound toward the assistant.



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3. The posterior layer of sutures is now placed, the long end of this caudal stay suture being used to sew with. In fact, this has been found to be the most satisfactory suture for both anterior and posterior rows. The suture is continuous, going first through the portal vein and then through the vena cava. They are both taken in one bite, and pulled through tightly after each suture. Slight tension on each suture prevents oozing from the last stitch hole. The sutures are placed about 2 mm. apart. When the cephalic or stay suture is reached, the sewing thread is tied to the shorter thread of the cephalic stay suture for locking. Then both the sewing suture and the stay suture are laid outside the abdomen toward the operator: this frees the field for the placing of the cutting suture. The needle is grasped so that the plane of the arc on the point of the needle is at right angles to the plane of the needle holder, since this is the only way in which it may be definitely known just where the point of the needle will pierce the vein. The portal vein is entered close beside the caudal stay suture, and the point of the needle directed cephalad until it is almost opposite the cephalic stay suture. The point of the needle rests against the portal wall, where it may be easily seen, and it is brought forth close by; all tension is taken off the point of exit by pulling the suture over the finger. If this is done, there will be no hemorrhage from this point. The cephalic stay suture and the sewing suture are laid over on the assistant's side of the field, so that they may be out of the way while the cutting suture is placed in the vena cava. Care must be taken to prevent the cutting suture from going around either of these two sutures. The cutting suture needle is grasped once more, as before, and this time the vena cava is entered beside the cephalic stay suture pointing caudad parallel to the line of suture. The point is brought out of the vena cava opposite its point of entrance in the portal vein. The cutting suture is tried gently to be sure that it slides easily.

4 and 5. The anterior row of sutures is laid, the corner being rounded with great care. The same thread is taken with which the posterior row was placed, and a bite is taken in the vena cava above the place where the cutting suture emerges and enters the vessels. This is followed with a corresponding one in the portal vein. Another suture is placed in the vena cava, this time in the line of the anastomosis, and just outside the line of the cutting suture; still another suture is placed in the corresponding position in the portal vein. One more suture is placed in the vena cava, and then gently, as the assistant makes slight pressure against the portal vein, these sutures are drawn up. The anterior row may now easily be laid.

In laying the anterior row of sutures, care must be taken to avoid catching the cutting suture. This should afford no difficulty since the cutting suture can be seen through the wall of the portal vein unless the wall is unusually thick, and it can be felt through the vena cava if it is raised on the needle as it pierces the vessel. However, with moderate care, there is no danger of its being caught. To be sure, the operator may slide the cutting suture freely back and forth after every two or three sutures, to assure himself that the cutting suture is quite free. All that is necessary is to keep outside the line of the cutting suture and to keep a slight tension on the sewing thread so that the walls of the veins are lifted in a slight peak before the next bite is placed. Should the cutting suture become caught the sutures are removed after the needle has been cut off, back of the point where the lock has occurred. One sewing suture is tied here, and another is started at this point. The oozing from the holes made can be controlled in a few seconds by pressure from the tip of the finger. The anterior row of sutures is continued to the point opposite the emergence of the cutting suture. Both ends of the cutting suture are laid anteriorly, and a final bite is taken in the portal vein, and another in the vena cava, both a little larger than usual but the suture is not drawn tight. The end of the sewing suture is placed out of the wound on the side of the operator.

6. To remove the cutting suture, each end is firmly taken between the thumb and forefinger of each hand, and sawed with long, gentle, even strokes. The cutting suture

should slide easily. If there is any oozing as it passes a weak point in the suture line, it can be stopped by the gloved finger tip. When the suture has been saved almost out of the lumen of the vessels the procedure is slowed since too much vigor at this stage

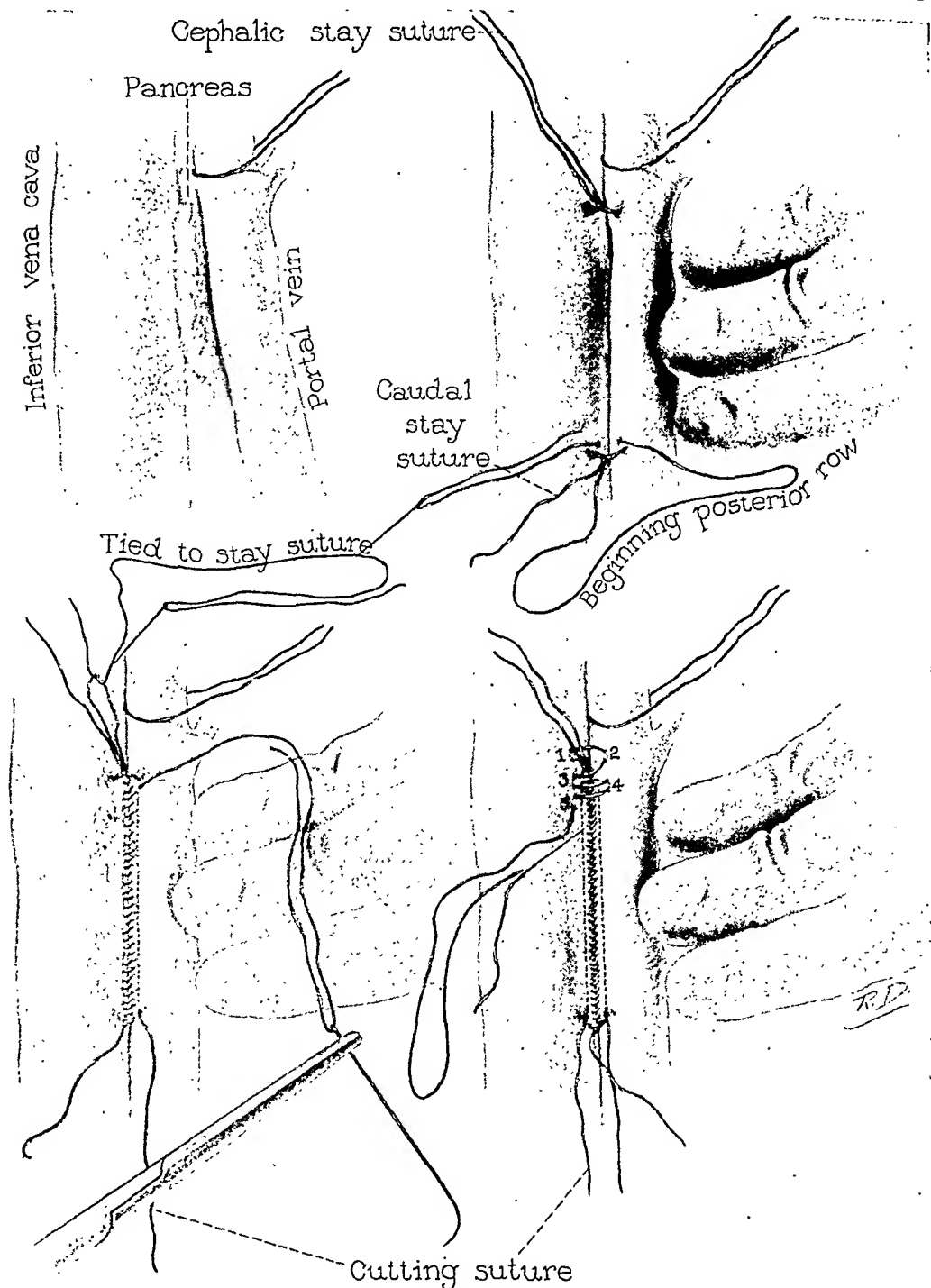


FIG. 1.—Carrying out, of the Eck fistula, stages 1 to 4

may cause a tear in the portal vein, and if the last stitch has caught the cutting suture, this may simply be pulled out without diminishing the extent of the anastomosis.

7. As the cutting suture is pulled out (stage 8 illustrates the manner in which cutting suture makes window) the two ends of the sewing suture are tied (one represents

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the caudal stay suture, and the other the one with which the anterior suture line has been placed). The suture line of anastomosis is examined for bleeding, and if necessary an individual suture may be placed. Clots may be removed from the abdominal cavity. The assistant moves his right hand and retracts the liver upward so that the operator may tie the ligature placed about the portal vein at the beginning of the operation. The

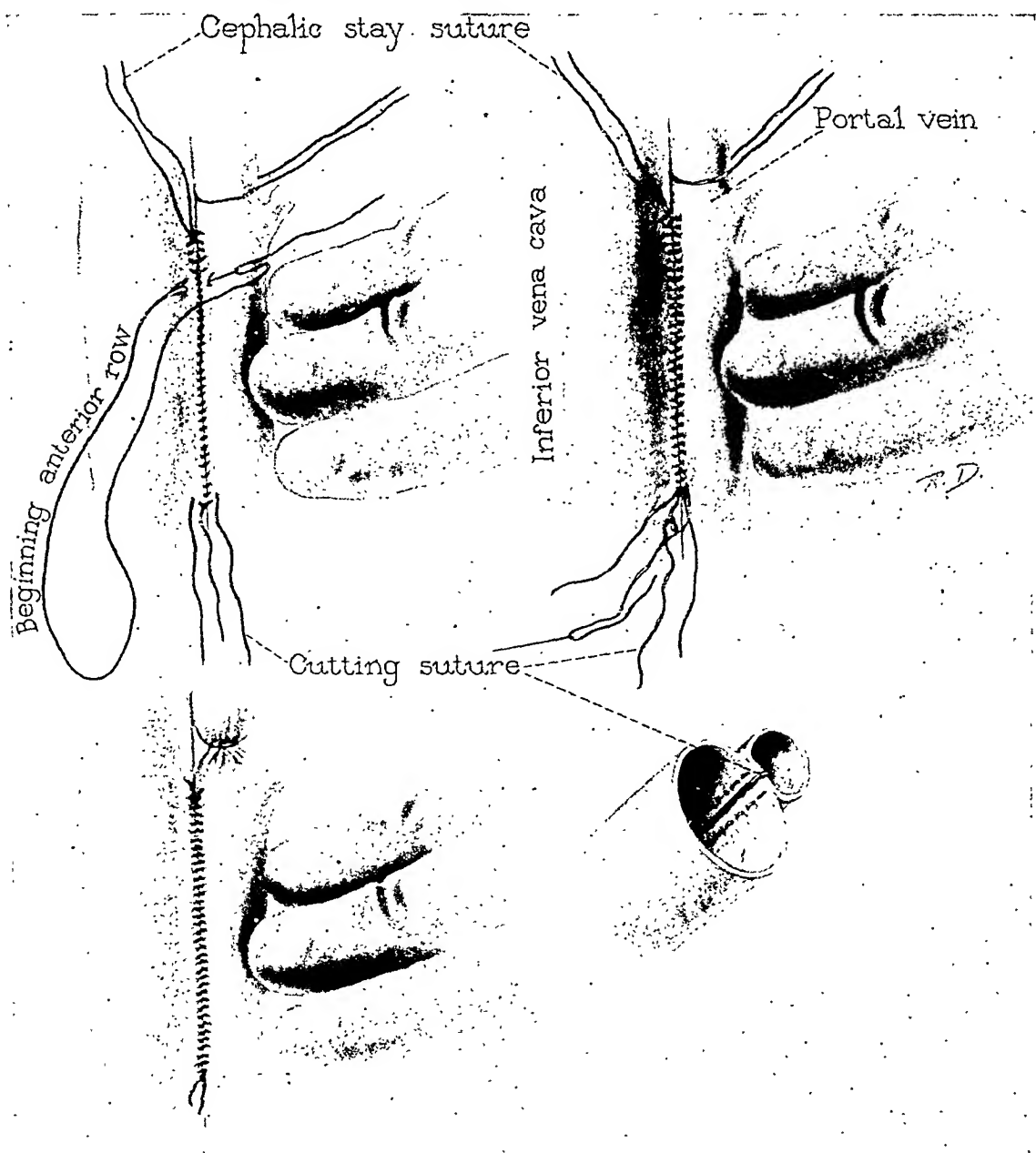


FIG. 2.—Carrying out of the Eck fistula, stages 5 to 8

ends of this ligature and of both stay sutures are now cut, and the operation is completed. (Figs. 1 and 2.)

*Closure.*—With a continuous suture of linen on a round, pointed, curved needle, the peritoneum and musculature are closed. Then two layers of continuous No. 2, iodized catgut on a cutting needle are placed, one through the fascia and the other through the subcutaneous fat. The skin is finally closed with linen on a spear-pointed needle. The only dressing is a single layer of gauze, which is painted with collodion, after the application of a single coating of iodine. In about a week the skin suture is cut and the wound is practically healed. Occasionally an abscess forms in the peritoneal suture

line. The suture can be removed without difficulty and the wound laid open around the abscess. The infected area is painted with iodine and dusted with drying powder.

*Dict.*—The dogs are given water immediately after operation. During the following day they are given the usual diet with the exception of meat. If they appear to be losing weight they are put on a high carbohydrate diet, consisting of half corn syrup and half milk, in sufficient quantity to increase the weight.

#### DISCUSSION

The operation for Eck fistula has been performed but rarely in man, and then only with a small degree of success. Vidal reported his first successful operation, performed in 1903 on a patient with cirrhosis of the liver and ascites. The patient lived four months, but the ascites recurred six weeks before death; death was due to an acute generalized infection, which he thought was of enterogenous origin. Vidal would not repeat the operation because it removed the liver as a filter from the portal circulation and side-tracked the hordes of microbes with undiminished virulence from the intestine directly into the systemic circulation and consequently death from septicæmia might be anticipated. He also believed that by shunting the liver in this manner, enough of its necessary functions were withdrawn to place almost impossible restrictions on the diet. The description of this case is quoted in most standard text-books of surgery and the authors agree with Vidal in not advising the operation.

In 1913, Rosenstein made the fistula successfully three times in man. He did not ligate the portal vein above the anastomosis. Simultaneously with him, Bogoraz transplanted, between clamps, the cut end of the superior mesenteric vein into the inferior vena cava; this was followed by beneficial results in a case of cirrhosis with ascites.

Quite recently Krestovsky duplicated the operation of Bogoraz with good results. He chose this type of operation instead of the true Eck fistula because he felt that by doing this he was leaving enough of the portal blood supply intact for the liver to maintain its deamination and detoxifying functions. He suggested that the wiser course would be to omit ligating the portal vein.

Whether or not an Eck fistula would benefit a patient with cirrhosis and ascites is still open to question. If the ascites is due to portal obstruction the Eck fistula should relieve it. If an Eck fistula were made early the ascites might conceivably be prevented, but as the cirrhotic process goes on, evidently other factors than merely portal obstruction enter the picture. Simply raising the resistance within the portal circulation is possibly not the sole cause of ascites.

Neither an Eck fistula nor any of the other procedures devised to remove the cause of the ascites, remedy the underlying cirrhosis, which is in turn responsible for the ascites. The operation carries far too great a risk to make the likely benefits worth while, except possibly in special instances.

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Many physiologic studies have been carried out on the Eck fistula animal with regard to the functions of the liver, but the conclusions arrived at in this manner have frequently been overestimated. The results are manifold and contradictory and confusing. Many of the animals do poorly and die from no particular cause. It is considered that the feeding of meat causes a particular type of intoxication resulting in death, and yet the manner in which poisoning occurs or why the animal dies is not known.

Certain investigators assert that Eck-fistula dogs can tolerate meat, others that they can if they have ground bone meal with it, while still others hold that not only meat, but meat extractives must be excluded from the animal's diet. However, in my experience dogs have been known to die in an intoxicated condition characteristically associated with meat poisoning, when no meat was given.

The technic described here should serve whenever a means of lateral anastomosis of veins is desirable. It is simple and rapid and requires no special instruments, only those used for ordinary blood-vessel surgery. It is offered as a thoroughly tested and exceedingly satisfactory method for making an Eck fistula.

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# THE TREATMENT OF POST-OPERATIVE SUPPURATIVE PAROTIDITIS\*

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IN A previous article † the writer contended that post-operative suppurative parotiditis is of hæmatogenous origin. Added experiences and observations have confirmed this contention as logical. Cultures made of pus have demonstrated the staphylococcus to be the dominating infective organism in a large majority of cases.

In a later article ‡ the writer classified post-operative infective parotiditis into three types, citing illustrative cases of each: (1) Acute parotiditis or simple inflammation. (2) Acute suppurative parotiditis. (a) Circumscribed parotiditis or lobular parotiditis; (b) diffuse parotiditis. (3) Gangrenous parotiditis.

From this article the writer quotes the first four conclusions:

1. Every post-operative parotiditis is a potential lethal factor until it proves itself benign.
2. To await spontaneous evolution of parotiditis is jeopardizing life.
3. Differential diagnosis of these types suggests at once the method of relief, medical or surgical.
4. When surgical, operate early, with free incision, and open drainage.

The writer insists on active interference in this infection, both medical and if necessary, surgical. "Watchful waiting" is not to be associated. As illustrative, however, of the medical possibilities in such cases, I present the following instances, the surgical aspects of this disease having been previously considered in other articles:

CASE I.—Mrs. M., age sixty-eight, suffering with general peritonitis from a perforated duodenal ulcer, was operated upon November 29, 1925. The ulcer was excised and closed; posterior gastro-enterostomy was performed with tube drainage in lower abdomen.

Temperature, 101; pulse, 124; hæmoglobins, 90 per cent.; reds, 4,400,000; whites, 7000; polymorphonuclears, 72 per cent.; lymphocytes, 24 per cent.; mononuclears, 4 per cent. Emaciated and septic; 1000 c.c. of 5 per cent. glucose solution were given intravenously and controlled with insulin.

On the third day a beginning parotiditis was noted. Four days later pus was massaged through Stenson's duct, culture of which demonstrated the staphylococcus. On the ninth day complete subsidence of parotid infection.

During the progress of the involvement, there were the associated symptoms of pain

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\* Read before the Surgical Section of the Academy of Medicine of Toledo and Lucas County, Ohio, March 25, 1927.

† ANNALS OF SURGERY, December, 1919.

‡ ANNALS OF SURGERY, November, 1923.

and swelling, delirium and restlessness, dysphagia and involvement of the seventh nerve. The daily blood examination shows the progress of the infection, when on the third day the polymorphonuclears were 89 per cent., the lymphocytes 11 per cent., and whites 23,000. Special attention is called to the temperature and pulse record; the highest temperature recorded was 101.2, the highest pulse rate 110. The course of the disease was marked mostly by a temperature of 99.6, pulse 92.

The treatment consisted in the repeated massage of the parotid, the use of mouth wash and gargle, chewing gum, and large amounts of water, per orem, intravenously hyperdermoclysis and enteroclysis. The local application of iodine to gland and the use of ice bag. Four hours following the inception of the infection 5 c.c. of mercurochrome was given intravenously. Following the third injection it was noted the advance of the disease was checked, and the succeeding two injections rapidly produced a subsidence except the effects of the seventh nerve involvement.

The blood picture, the temperature and pulse, are significant and synchronous with the rise and fall of the infective process.

CASE II.—Mrs. M., age twenty-three, was operated at St. Vincent's Hospital, April 21, 1926, for acute appendicitis and chronic infective tonsillitis.

Bronchitis developed with temperature 101 and pulse 138. Five c.c. of uritone was administered intravenously and repeated the following day, with the result of a subsidence of symptoms.

Fifth day left parotiditis developed and progressed to a diffuse inflammation of gland. The clinical picture is almost identical with Case I.

On the third day the white count shows 13,650, the highest. The temperature 101 and pulse 110.

Six days later complete subsidence of symptoms, except a nodule still remaining in the parotid in the submandibular fossa. Five days later suppuration ensued in this lobe and did not extrude itself through Stenson's duct.

A recurrence of her infective symptoms developed with delirium, restlessness and severe pain in ear. Temperature 100, pulse 110, whites 14,100.

Five days later patient agreed to operative intervention. This circumscribed or lobular abscess was opened and drained. Culture of pus showed staphylococcus.

The treatment as outlined in Case I was immediately begun on the first appearance of inflammation. Six intravenous injections of 5 c.c. mercurochrome were given, over a period of seven days.

CASE III.—Mrs. P., age forty, suffering with relaxation of pelvic outlet with retroversion of uterus, was operated upon November 4, 1926, at St. Vincent's Hospital. Extensive anterior and posterior colporrhaphy, perineorrhaphy, and Gilliam-Crossen ligament operation were performed.

On the second day a beginning right parotiditis was noted. Temperature 101, pulse 100, restless, drowsy, pain in neck and face, profuse expectoration. White count 19,650.

On the third day symptoms aggravated, temperature 102, pulse 100.

The fourth day decided improvement in all symptoms; highest temperature 100, pulse 100, whites 11,700.

Subsidence of the suppuration on the tenth day of the inception of the infection, spontaneous evolution through Stenson's duct having taken place.

Culture of pus shows staphylococcus as the offending organism. The same medical treatment was here adopted as in the other two cases.

In a period of five days, four intravenous injections of 5 c.c. of mercurochrome were given, the first, four hours after the inception of the disease. Improvement was noted after second injection.

CASE IV.—Mr. A. K., age eighteen, was operated upon December 8, 1926, at St.



## POST-OPERATIVE SUPPURATIVE PAROTIDITIS

Vincent's Hospital for general suppurative peritonitis due to gangrenous perforated appendicitis.

On the fifth day a beginning left parotiditis was noted in the submandibular fossa. This became diffuse on following day with temperature 101, pulse 120, whites 12,300, and was accompanied by the usual symptoms of parotiditis.

The course of the disease continued for seven days, the temperature and pulse fluctuating from the highest 101 and 120 to normal.

The highest leucocytes were on the third day 16,300, after which a daily examination shows a decline to normal.

In this period of seven days, the patient received the usual routine treatment. Five intravenous injections of 5 c.c. mercurochrome were given, the third day of which produced marked amelioration of symptoms.

Culture of pus from Stenson's duct shows staphylococcus.

*Comments.*—The writer has been unfortunate in having had many cases of post-operative infection of the parotid gland in its various manifestations, which have led to the clinical formation of the foregoing classification.

From the onset and progress of the selected illustrative cases above reported, I feel assured, clinically, that these cases checked in the beginning and due entirely to the staphylococcus as the inciting organism, would have progressed to the second type of classification or acute suppurative parotiditis of the diffuse variety, with destruction of the entire gland, necessitating the radical operation, and the possibility of a fatal termination.

Diffuse parotiditis represents surgical pathology of grave importance. The type is rare, and few cases, if any, are met with in the life work of the individual surgeon. Collectively there are many case reports.

Differentiation of less severe types may be determined as the hours elapse, as to probable severity, by the increase of both objective and subjective signs.

At no stage of the inflammation is there a diminution in the severity of symptoms; suppuration occurs early, from thirty-six to forty-eight hours; immense swelling of face; dysphagia; meningeal disturbances and seventh nerve irritation, associated with repeated chills, rigors, and high temperature, rapid pulse, and increased leucocytosis.

Comparing this clinical syndrome with the foregoing case reports, it must be admitted that, up to the beginning of the second or third day of the infection, the signs and symptoms are similar and of equal importance.

The treatment advocated has produced a marked amelioration of symptoms after the third day, when lethal results are to be anticipated.

Mercurochrome has a powerful selective destructive action on the staphylococcus, and it was this therapeutic action that led the writer to employ its use at the first sign of parotid involvement.

The writer doubts its usefulness in antagonizing other infective organisms of the parotid, but advocates its use in all infections of the gland, where possibly the staphylococcus may be the exciting cause.

In debilitated and exsanguinated cases, small doses as above are indicated, but in grave cases massive doses may be employed.

Reaction was noted in the administration of 5 c.c. in the above cases; in some, a rise in temperature and diarrhoea with abdominal pain; in one, involuntary evacuation.

SUMMARY

(1) When parotid suppuration results from the staphylococcus, the intravenous administration of mercurochrome in conjunction with proper post-operative care, will abort a destructive diffuse parotiditis to a benign.

(2) Daily intravenous administration of which should check or hold in abeyance the progress of the infection after the second or third dose.

(3) Then if no improvement, the case assumes surgical aspects, and proper surgical procedures should be adopted immediately.

(4) The gangrenous types, although all reports show invariably a fatality, mercurochrome should be tried with early incision and drainage.

(5) The writer calls attention to the Y incision which he advocated in a previous article, and which meets all the indications of the gangrenous type of parotiditis; extending from the zygoma in a curvilinear manner, following the sterno-cleido-mastoid to the supra-clavicular notch. Its posterior limb extending from the mastoid and joining it below the angle of the jaw.

# TRANSACTIONS

OF THE

## PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held April 4, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

### FLAIL ARM FROM INFANTILE PARALYSIS

DR. J. TORRANCE RUGH presented a man, twenty years of age, who at the age of one year had been left with a practically flail arm as the result of an attack of anterior polymyelitis. There was no power about the left shoulder-joint except in the pectoralis major; the head of the humerus could be moved in any position about the glenoid cavity; relaxation was very great; there was no life in any of the muscles from the shoulder to the elbow; below the elbow he had slight power in the flexors and in the extensors of the fingers and also in the extensor carpi radialis, but none in the ulnaris and in the carpal flexors. The hand was in a position of exaggerated radial deformity and was also pulled upward in extension. The arm hung limp at the side and if he wished to raise it, the assistance of the other hand was required.

On February 17, 1925, Doctor Rugh operated upon the shoulder-joint, doing an arthrodesis, removing the cartilage from the head of the humerus, from the surface of the glenoid and from the under surface of the acromion, and from the tip of the coracoid. The arm was placed in a position of sixty degrees of abduction and the head of the bone was held in contact with the acromion, glenoid and coracoid by a kangaroo tendon suture passed through the head and tied over the top of the acromion. An aviation splint was applied to hold the arm in place. Infection of the wound occurred and was quite acute for a few days, but in two weeks it was completely healed and union between the humerus and the scapula took place. After four months' time, the brace was gradually removed, but the union, which was fibrous, was not sufficiently strong to maintain sixty degrees of abduction and the arm sagged to about forty degrees, in which position it now remains.

April 14, 1926, the elbow-joint was operated upon; the external condyle of the humerus was removed with the attachments of the extensor muscles and a flap of periosteum and bone was lifted from the front of the humerus about two inches above the elbow-joint and the condyle attached at this point by heavy catgut sutures. The arm was dressed in position of complete flexion and maintained in this position for three months until the parts had grown solidly together and then manipulation was begun to gradually straighten the arm at the elbow. This transplantation allows the patient to flex his arm completely, even when it is hanging down at his side, as there is a pull of the muscles from above the joint.

November 20, 1926, an osteotome was introduced into the carpal area on the outer side of the hand, destroying the carpal bones and their articulations, together with the cartilage on the lower end of the radius and ulna

and the proximal ends of the metacarpal bones. The hand was placed in the ulnar position as far as could be done and set straight with the radius and ulna. A plaster splint for this part has been worn until to-day (April 4, 1927), and now he is able to open and close his hand perfectly well and to grasp objects and hold the same, a function which he had not since the onset of his paralysis.

Operative procedures have therefore succeeded in giving this boy the ability to raise the arm about forty degrees from the side and to lift it upward and forward through the action of the scapula muscles; also to flex and extend the arm at the elbow and to grasp and hold objects with his fingers, all of which functions have been heretofore absent. As the pronation and supination of the hand are gone and the hand is in a position of pronation, it will be allowed to remain there.

#### PLEURAL CAVITY AND BLOOD STREAM INFECTION WITH BACILLUS WELCHII

DR. HENRY P. BROWN and DR. D. W. KINGSLEY (by invitation) reported the history of a man who was admitted to the Presbyterian Hospital, December 13, 1926, in the service of Dr. Edward B. Hodge. He had been shot in the left chest about half an hour prior to admission. Examination revealed a penetrating wound, just beyond the lateral border of the scapula. No wound of exit could be demonstrated. The heart was displaced to the right about three cm. and there were dulness and a suggestion of a friction rub over the base of the left lung. X-ray examination showed the bullet in the left chest, at the level of the tenth rib lateral to the spine and anterior to the chest wall. Two days after admission, the temperature rose to 103 and there was a general increase in the physical and röntgenologic signs of fluid in the chest. The blood showed 16,800 leucocytes. During the next eight days there was virtually no change in the general condition; but the temperature had fallen to 101 and the leucocytes to 9700. On account of increasing respiratory embarrassment, thoracentesis was performed on December 21 and 22. The aspirated fluid was dark and watery, 920 c.c. and 7500 c.c., respectively, being removed. Culture of the first fluid was sterile, but that of the second grew a non-hæmolytic streptococcus. As the latter sample had been inadvertently placed in a non-sterile container, this was thought to be contamination. The withdrawal of fluid afforded marked relief of symptoms. On the fourteenth day, after admission, the temperature suddenly rose to 105 and the patient became very toxic. The wound in the chest wall showed nothing to account for this. The chest was again tapped and 400 c.c. of fluid withdrawn, which upon examination showed a growth of bacillus Welchii and streptococcus non-hæmolyticus. Upon the advice of Dr. John Jopson, a rib resection was performed, for the provision of better drainage, and 300 c.c. more of fluid was removed. The operation was followed by a rather sharp rise in temperature and an alarming fall in blood-pressure (78 S-5 OD). A blood culture taken on the same evening was later reported positive for bacillus Welchii. Antitoxin was administered during the next six days in amounts totalling 360 c.c., of which 50 c.c. was given intrathoracically and 310 c.c. intravenously. Following the first administration of serum, the temperature fell by lysis from 106 to 100, with a concomitant improvement in the patient's general condition. Subsequent blood cultures failed to show any growth; but bacillus Welchii continued to be obtained from the thorac-

## SPONTANEOUS RUPTURE OF GALL-BLADDER INTO DUODENUM

otomy wound. Inoculation of a rabbit proved the identity of the organism beyond question. The chest wound was treated by dakinization and recovery preceded normally, being complicated by the slipping of one of the tubes into the pleural cavity. Fortunately Doctor Brown was able to withdraw the tube and incidently the bullet, with the aid of the fluoroscope. The patient was discharged March 4, 1927, with the chest wound practically closed.

The unusual features presented by this case are:

1. The invasion of the blood stream by the bacillus *Welchii* which is said to occur very infrequently except immediately before death.
2. A low leucocyte count throughout the period of invasion.
3. The consistently low blood-pressure.
4. The beneficial effect of serum on an apparently hopeless case.

DR. HENRY P. BROWN, JR., said that the cause of the infection in the pleural cavity is not clear; if due to the bullet, he should have shown some infection of the muscles of the back but at no time was there evidence of such involvement. The organism was not recovered for fourteen days, at which time, communication between the pleural cavity and the chest wall had become sealed off.

DR. EDWARD B. HODGE remarked that when the patient was seen two days ago, the wound was solidly healed and he was entirely well. The speaker mentioned in this connection the recent observations of Dr. Urban Maes, who reported some cases which he was unable to trace to soil contamination and found that woolen clothing, even if clean, very frequently carries bacillus *Welchii*. This opens up a new field, as to the possible source of such contamination in wounds.

## SPONTANEOUS RUPTURE OF GALL-BLADDER INTO DUODENUM

DR. HUBLEY R. OWEN presented a man, age forty-five, who was admitted to the Philadelphia General Hospital, February 1, 1926, with the chief complaint of vomiting blood. January 30, 1926, while in bed the patient was awakened with severe abdominal pain, which lasted about an hour. He then vomited a large amount of bright red blood. The vomitus also contained food taken the night before. This was followed by profound weakness and sweating. There was no history of any previous attack relative to the stomach with the exception of considerable gaseous and acid eructations for two or three weeks prior to admission. On the morning of admission the stools were black and tarry. There was no history of loss of weight. The past medical history was essentially negative. On admission the temperature was 98, pulse 90, respiration 20. He was able to be up and about the ward, and did not look acutely ill. Abdominal examination revealed the liver palpable below the costal margin. No masses were felt. No points of acute tenderness. Blood Wassermann was negative. The blood count showed a mild secondary anaemia, with 17,800 leucocytes. X-ray examination resulted in a tentative diagnosis of duodenal ulcer, but suggested the possibility of a fistulous communication between the gall-bladder and the duodenum. At operation, February 11, 1926, the second portion of the duodenum was found attached to the gall-bladder, and there was a fistulous opening between the

gall-bladder and duodenum, the former was, however, normal in size and color. About six inches from the pylorus there were several broad bands of adhesions running across the duodenum. These were ligated and severed. The head of the pancreas was hard and nodular and at that time was thought to be malignant. The conus of the duodenum was considerably distorted and bound down with adhesions, which prevented proper evacuation of the stomach contents through the pyloric ring. Posterior gastro-enterostomy was performed. The patient made an uneventful recovery and was discharged from the hospital February 24, 1926. X-ray examination nine months after operation showed the gastro-enterostomy functioning and the fistulous communication still present between the gall-bladder and the duodenum.

### PERFORATING JEJUNAL ULCER

DR. E. L. ELIASON presented two patients illustrating the above condition.

CASE I.—A man, age thirty-three, who in July, 1925, first began to have attacks of epigastric pain of a dull aching character which came on from thirty minutes to two hours after taking food. These pains were so distressing as to keep him from working, and would wake the patient from sleep about 2 A.M. when he would have to get up and take soda as these pains were relieved by taking food or by soda. March 8, 1926, the patient entered the University Hospital with the diagnosis of duodenal ulcer. He was operated upon March 29, by the reporter, at which time gastro-enterostomy and appendectomy were done. The ulcer was found and oversewed. The patient felt very well for about three months after the operation, during which time he gained weight and was free from symptoms. Then severe pain in the side radiating to the back and to the testicle developed. These pains had no relation to meals, were colicky in character and came on any time during the day and night. In August, 1926, the attacks became so severe that the patient was obliged to stop work. December 3, 1926, he again entered the University Hospital and was discharged on the 15th. At this time gastro-intestinal X-ray study was made and reported negative. Urinalysis revealed red blood corpuscles on two occasions. While in the hospital he felt better. On January 14, 1927, he was readmitted. Cystoscopic examination was negative for calculus. Patient was discharged ten days later, feeling better. On February 4, 1927, he had a sudden attack of pain in the abdomen, sharp, stabbing in character, localizing a little to the left of the umbilicus. This pain continued until the afternoon of the following day. Pressure on the abdomen as by leaning over a banister or chair gave some relief. He states that while doing this he suddenly felt something "pop" inside his abdomen, after which he had immediate relief. That night he felt weak and restless. The stools were tar-like in appearance. Fluoroscopic examination of the stomach revealed a normally functioning stoma. The opaque meal entered the jejunum but after progressing about two inches would stop and regurgitate into the stomach. A diagnosis of jejunal ulcer was made. Examination of the abdomen revealed slight but definite rigidity of the upper left rectus muscle. No tenderness noted. Peristalsis was slightly exaggerated. At operation the gastro-jejunostomy was delivered partially and with the finger inverting the anterior wall of the stomach, the stoma could easily be palpated. About two inches below the gastro-enterostomy an ulcer of the jejunum was found which was adherent at its outer side to the transverse mesocolon. By putting the jejunum on tension, it could be separated by blunt dissection

## PERFORATING JEJUNAL ULCER

from the meso-colon until the ulcer was reached, at which site the erosion made an opening into the gut. It had eroded a small vessel in the transverse meso-colon from which the hemorrhage occurred. The meso-colon was dissected away enough to allow about one-half inch of jejunum distal to the enterostomy opening so that the opening could be inverted and oversewed. After a stormy convalescence the patient recovered and left the hospital in good condition, with no symptoms of a gastro-intestinal nature. Six weeks following the last operation, the patient was admitted to the hospital because of a hemorrhage from the bowel. This was bright red and probably came from near the anus. Sigmoidoscopic examination showed its possible origin to be hemorrhoidal.

CASE II.—M. M., male, age twenty-nine, first admitted to the Howard Hospital complaining of severe pain in the abdomen, associated with vomiting and weakness. His family physician had diagnosed the condition as due to a perforating duodenal ulcer. A laparotomy by the reporter disclosed a subacute perforation of a large indurated duodenal ulcer with a small abscess at the site. The ulcer was burned out with the cautery and a posterior gastro-jejunostomy of the anti-peristaltic short-loop type performed on May 27, 1922. The infection from the abscess resulted in a breaking down of the laparotomy wound which finally healed with a wide but solid scar. There followed sixteen months of freedom from symptoms when the patient was again admitted in Doctor Eliason's service suffering with the symptoms of a left abdominal catastrophe, having been seized three hours previously with severe knife-like pain in the left side of the abdomen just opposite the umbilicus. He was not nauseated nor did he vomit. On admission his temperature was 100, pulse 120, respiration 22. The abdomen showed board-like rigidity and was tender. The leucocyte count was 16,000. A diagnosis of ruptured jejunal ulcer was made and operation advised. At operation there was revealed a diffuse acute chemical peritonitis and a perforated ulcer in the jejunum opposite the mesentery two or three inches below the gastro-jejunostomy. The ulcer was cauterized and closed with tier sutures. The pylorus was occluded by double ligating with No. 3 kangaroo tendon. The patient recovered and left the hospital in good condition. From then until the present his health has been good and his gastro-intestinal tract has been kept practically normal by the regular use of alkalis. Examination last month revealed a normally acting stoma and a closed pylorus.

At operation both cases presented a much dilated, congested and thickened jejunum; both cases had a perforated ulcer in the distal loop and normally functioning stomata.

DOCTOR ELIASON added that ulceration at the line of suture or in the jejunum close thereto occurs almost exclusively after operation for simple disease, that is, ulcer in contra-distinction to carcinoma. In only one case in the literature (Axel Key) was the anastomosis performed for carcinoma. According to Moynihan the ulcer may be single or multiple, usually situated at the opening; it may be in the proximal jejunal loop but is usually in the distal loop. Jejunal ulcer may occur following any type of gastro-jejunostomy or it may occur primarily in the absence of any gastro-enterostomy, as was the case in a patient reported in the *ANNALS OF SURGERY*, 1926, by Barber. Barber's patient had had a gastric ulcer perforate twice before a

jejunal ulcer perforated. Van Roojen found it three times as frequent in the anterior type of anastomosis as in the posterior type. The frequency of occurrence in all cases as found by Deaver in a series of 3869 cases was 0.75 per cent. The vast majority of the cases reported up to 1921 showed the first symptoms between six and eighteen months, but three cases occurred within three days (Van Roojen). Leiblein in his study of seventy-nine jejunal ulcers found 30 per cent. perforated. Of the 70 per cent. chronic cases, fifty-five in number, eighteen required two or more operations. Moynihan reports a case that perforated five times. A review of 148 cases of gastro-jejunostomy for duodenal ulcer admitted to the Medical Service of the University of Pennsylvania Hospital, reveals three cases of supposed jejunal ulcer. Examination, however, found none proven.

#### MULTIPLE GIANT-CELL TUMORS

DR. EMORY G. ALEXANDER and DR. W. H. CRAWFORD (by invitation) read a paper with the above title, for which see p. 362.

DR. RALPH BROMER showed slides which illustrated the usual type of bone cyst, chronic cystic osteitis and giant-cell tumor. He considered Doctor Alexander's case as unusual in that it has a peculiar moth-eaten appearance of the bones and so is unlike the usual type of chronic cystic osteitis. Giant-cell tumors of the shaft are rare. One case, reported two years ago as a giant-cell tumor of the middle of the shaft was so classified by two pathologists who first saw the pathological sections but when sent to the Bone Sarcoma Registry, it was there classified as a bone cyst.

DOCTOR EWING has said that this region is more productive of unusual types of bone tumors than any other. Dr. C. Y. White diagnosed this tumor as chronic cystic osteitis with giant-cells. The tumor has a narrow transverse diameter as compared with its length. The number of epulis type of foreign body giant-cells in the sections was greater than usual in cases of chronic cystic osteitis, but scarcely sufficient to warrant a diagnosis of giant-cell tumor.

At the International Radiological Congress in London, 1925, Kienböck, in a paper on the classification of bone tumors, drew attention to the so-called Engel-Von Recklinghausen type, otherwise known as *osteitis fibrosa tumerosa cystica generalisata*. In this type multiple giant-cell tumors occur with the usual changes of chronic cystic osteitis. It is also characterized by clubbing of the fingers and a marked translucent appearance of the phalanges of the hands. It seems that this case might be of this type.

The speaker asked Doctor Crawford, whether in reviewing the literature on this subject he had found anywhere a report of the occurrence of multiple giant-cell tumors with absolutely normal bone elsewhere than at the sites of the lesions. He could find none and Doctor Brower believes that Codman is right when he says that he is skeptical of the existence of multiple giant-cell tumors. Bloodgood thinks they occur in the proportion of about one in



## OBSTETRICS BEFORE AND AFTER LISTER

25,000 cases. This case should probably be classified as one of chronic cystic osteitis with multiple giant-cells, probably an advanced stage of the usual chronic cystic osteitis or osteitis fibrosa cystica.

## OBSTETRICS BEFORE AND AFTER LISTER

DR. GEORGE M. BOYD, by invitation, read a paper with the above title. This paper was read in connection with the centennial of Lord Lister and consisted of a comparison between the pre- and post-Listerian eras in obstetrics. The essayist recalled that at one time it was a matter for serious consideration that all lying-in hospitals be closed, as the mortality from puerperal sepsis was so high that a woman going to such an institution to be confined, stood less than an even chance of surviving. The introduction of antiseptic methods into obstetric practise was followed almost at once by a reduction in the number of such cases to the point where "child bed fever" is to-day regarded in most instances as a direct reflection on the obstetrician. Doctor Boyd's presentation was profusely illustrated with lantern slides.

# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting Held April 13, 1927*

The Vice-president, DR. FRANK S. MATHEWS, in the Chair

### CIRRHOSIS OF LIVER—OMENTOPEXY

DR. JOHN DOUGLAS presented a man, age forty-seven, who was presented before the Surgical Society two and a half years ago and the case reported in the *ANNALS OF SURGERY*, 1925, vol. lxxxii, p. 712, in which the details of the history and operation and comments thereon may be found. At the time of operation, which was an omentopexy, done under local anæsthesia, the prognosis appeared to be very bad. When previously presented it was only about one year after his operation. He is now presented three and a half years after operation and he is apparently in excellent health and doing heavy work. It is of interest that notwithstanding his apparent cure, there is an absence of the dilated abdominal veins which one expects to find after an omentopexy.

DR. RALPH COLP said that several years ago he assisted in collecting a series of cases of omentopexy from the records of the Presbyterian Hospital. The results seemed to show that in the cases that had been tapped a number of times and then subjected to operation the result was poor, but in those tapped only a few times and then operated on the prognosis was fairly good. After reflection upon this subject in recent years, it has seemed to the speaker that as the collateral circulation in cirrhosis is usually great, and as occasionally these patients do recover without operation, that the small tab of omentum which is brought out so as to establish anastomosis with the epigastric vessels would seem to have little to do with the ultimate cure. In the case Doctor Douglas showed there is little evidence locally that anastomosis has taken place and that is another indication that the operation as such probably has little to do with the cure of these patients.

DR. ROBERT T. MORRIS asked about the stage of the cirrhosis. The only good result he has obtained with omentopexy was when there was still some hypertrophy and in advance of replacement of parenchymatous connective tissue. Some time ago he devised a brush for removing endothelium from the surface of the liver. The brush has very short, stiff bristles and a curved back and handle. When the dome of the liver is thoroughly brushed the resulting adhesions allow of some blood and lymph circulation in addition to that given by omentopexy.

DOCTOR DOUGLAS, in closing the discussion, said that undoubtedly the number of cases of cirrhosis cured or relieved by omentopexy is limited.

## CONTRACTURE OF ELBOW

But as far as the collateral circulation is concerned, he had called attention to the fact that this man has very few large superficial veins. In doing the operation under local anæsthesia (for general anæsthesia is likely to cause an early exitus), he makes an attempt with the sharp edge of a knife to scrape off as much endothelium as possible where the omentum is attached and while few of these cases do improve or get well after operation, it must be a little more than coincidence that some do get well, such as this man, for instance. He was tapped every ten days and was desperately sick before operation. Replying to Doctor Morris as to the state of the liver, the cirrhosis was in the atrophic stage; the man had a hobnail liver, but only a moderate amount of involvement of the spleen.

## CARCINOMA OF THE RECTUM

DR. JOHN DOUGLAS presented a man, age fifty-two, who was admitted to the Knickerbocker Hospital in December, 1926, with acute intestinal obstruction. Rectal examination showed a mass well above the prostate which appeared to be an annular carcinoma. December 20, 1926, a colostomy was done, under local anæsthesia, the sigmoid being pulled through a left rectus incision. This was intended as a permanent colostomy, a combined abdominal perineal resection being planned later. The patient was much emaciated and in poor condition, but by January 20, 1927, was deemed able to stand the second operation. A right rectus incision was done and the speaker was surprised to find that although the growth was palpable by finger in the rectum, it was sufficiently above the peritoneal reflection over the bladder to allow its complete removal with a restoration of continuity of the intestine. At the time of the operation, it was observed that a loop of small intestine had slipped through the space lateral to the colostomy but was not obstructed. This space was carefully closed. Subsequently, the colostomy spur was cut through with a Mikulicz clamp and on February 9 the colostomy was closed. It was of interest at this operation to find that with the finger of one hand in the colostomy above and the finger of the other hand in the rectum, the two fingers could be made to touch at the point of anastomosis where very little narrowing was present.

This case he presented to call attention to the fact that occasionally in a small thin patient, an annular growth which has not prolapsed from above, can be felt by rectum and still be above the peritoneal reflection allowing a resection of the upper rectum without a permanent colostomy; also to call attention to the not infrequent occurrence, or possibility of intestinal obstruction due to a loop of small intestine slipping through the opening lateral to the sigmoid at the point of colostomy. The speaker lost one patient several years ago from this cause.

Perhaps the chance of recurrence in this patient might have been minimized by a complete abdominal perineal resection, but no enlarged glands were present and his general condition was such that the more extensive procedure would have greatly increased the operative hazard.

## CONTRACTURE OF ELBOW

DR. JOHN DOUGLAS presented a girl, age seven, who was admitted to the Knickerbocker Hospital, Out-patient Department, November 20, 1925, with a severe burn of the right arm. By the time the burn had healed and epithelialized, there was a contracture of the elbow preventing extension

beyond 90 per cent. A plastic operation was suggested, but permission refused by the parents. An apparatus (see Fig. 1) was applied, which in less than three months resulted in complete extension.

Also a boy, aged nine, who was admitted to the Knickerbocker Hospital, December 13, 1926, with a complicated fracture-dislocation of the elbow-joint. The upper end of the ulna was fractured, the head of the radius dislocated forward, and a fissure without displacement was present in the lower end of the humerus. The replacement of fragments was most effective in the position of acute flexion.

January 3, union was present but extension only possible to 100 degrees. The extension apparatus was applied and by March 3 extension was to 170 degrees.

*Description of Apparatus.*—Two pieces of  $\frac{3}{4}$ -inch board 4 inches by 7 inches are united at the ends with a heavy "screen door spring" with a pull of four to five pounds, and covered with heavy felt. Two  $\frac{3}{4}$ -inch

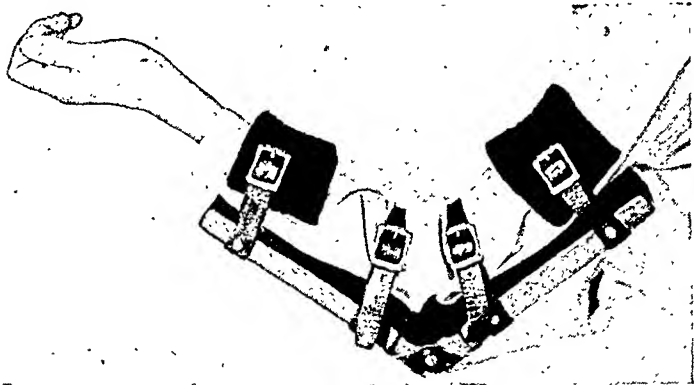


FIG. 1.—Apparatus for gradual extension of elbow-joint.

straps are then fastened to each piece of board to attach apparatus to the arm and forearm. Heavy felt is attached to the two end straps to act as cuffs. This is applied to the flexed extremity and the spring makes a constant pull in the direction of the extension. In the beginning, if painful, the splint may be applied for only a

few hours at a time. Later it can be worn practically continuously without pain until extension is complete. It is necessary to use the  $\frac{3}{4}$ -inch board on account of the size of the spring attachment. (Fig. 1.)

DR. SETH M. MILLIKEN said that in this contracture of the elbow due to burn, the contracture is of the skin due to the scar and is very narrow. Resistance of the scar is relieved by the development of the surrounding soft parts which give and while that is a contracture due to a scar of the skin, recovery in those cases is very rapid and spontaneous in children. Doctor Milliken said he wished to differ with the diagnosis in the second case; he did not think it was a contracture about the elbow-joint; it is a contraction of the flexor muscles of the forearm. The arm was put in the Jones position and the muscles hold it in flexed position. A child will always regain full extension if left alone because the muscles gradually relax. They have been held up and they are lame when first released, but they will come down. The boy seemed to have bony limitation at present amount of extension. If there is no interference by bone about the joint, complete extension supervenes spontaneously.

DR. HENRY H. M. LYLE said that the splint presented by Doctor Douglas was simple and efficient. He had made extended trials with several of the best known internal splints but has abandoned them as being unsatis-

## BANTT'S DISEASE FOUR YEARS AFTER OPERATION

factory. They are mechanically bad and physiologically unsound. From a mechanical standpoint all splints applied on the internal aspect of the arm must of necessity have a very short upper arm piece, as the distance between the elbow crease and the axilla leave but little room for a suitable mechanical leverage as compared with the splint applied to the outer arm. Internal splintage to overcome a contracture of the elbow is contrary to sound physiological and psychological principles. For instance, if you place a weight in the palm of the patient's hand he involuntary flexes the arm to sustain the weight—that is his natural reaction. Now if you attach the same weight to the back of the hand the natural reaction is to extend the arm. Try this experiment on yourself and be convinced. The power to heal is the property of all living tissue, but the power to recover function—the function of muscles and joints is the property of the patient's will and brain. Doctor Douglas' splint is simple, efficient, and based on sound physiological principles.

DOCTOR DOUGLAS, in closing the discussion, said that when the girl came from the Out-patient Department the skin was contracted; it was not the subcutaneous tissues. There was a web across and there seemed little possibility of straightening it out without operation. It might have been done in time but not so soon by other means as by this splint. As to the boy, Doctor Douglas was willing to acknowledge that contracture was not the best term to apply to this case of elbow-joint fracture, but he could not think of a better one and so had let it stand. As to shortening of the flexor muscles of the arm, the speaker did not think this contracture was due to that, but to a thickening and contracture of the capsule and fibrous tissue around the true capsule of the joint. As to the belief that the present limitation is entirely bone, two months ago it felt just as bony as it does now, but extension has increased 60 degrees.

## BANTT'S DISEASE FOUR YEARS AFTER OPERATION

DR. JOHN DOUGLAS presented a boy, age fourteen, who was admitted to the Knickerbocker Hospital, December 9, 1922. He gave a history of having had two hemorrhages, eight hours apart, from the stomach the day before admission. Each hemorrhage was said to consist of clotted blood to the amount of one pint each. He had bled from the gums at times during the previous year and had suffered from headache for two weeks previous to admission to the hospital. His spleen at this time was palpable. His red blood count was 3,000,000; hæmoglobin 54 per cent. with 10,000 leucocytes and 89 per cent. of polymorphonuclear cells. His stools showed blood by the benzedin test, but no gross blood was present. On December 23, two weeks after admission, his blood count had dropped to 2,000,000 with 42 per cent. of hæmoglobin, the leucocyte count being 6000 with 67 per cent. of polymorphonuclear cells. He was transfused on December 29 and again on January 6, after which his blood count was 3,650,000 with 65 per cent. of hæmoglobin. On January 8, 1923, a splenectomy was done.

The spleen weighed fourteen ounces and the liver was decidedly cirrhotic in appearance, but no fluid was present in the abdomen. Following his operation, he had no further hemorrhages and his red blood count and hæmoglobin rapidly improved. In six weeks his hæmoglobin was 60 per

cent.; red cells 4,720,000. Nine months later his hæmoglobin was 80 per cent.

During the four years since his operation, he has been followed but has always been somewhat anæmic, although he has taken iron and arsenic at intervals since then. A recent blood count showed 3,600,000 red blood cells; 75 per cent. hæmoglobin; 11,600 leucocytes with 70 per cent. polymorphonuclear cells. The eosinophiles were 4 per cent.

He was born in Porto Rico and a search of the stools for ova showed nothing.

Concerning the diagnosis in this patient, the pathological examination of the spleen showed increased fibrosis with diffuse overgrowth of all the tissue elements found in the spleens of splenic anæmia. The spleen weighed, after the blood had drained out, 476 grams—there had been gastric hemorrhages—all of which supported the diagnosis of splenic anæmia. In addition, there was a markedly cirrhotic change in the liver, which would appear to be a further progress in the pathological condition known as splenic anæmia to the more marked pathological condition known as Banti's disease, although this had not advanced to the development of ascites.

This patient then would belong in those cases of the adult type of splenic anæmia in children, which seem to differ somewhat from the splenic anæmia of infancy, or Von Jach's disease. In the latter there is a leucocytosis of from 10,000 to 100,000, with a lymphocytic prominence, more marked blood destruction with the hæmoglobin sometimes as low as 25 per cent., usually normoblasts and frequently megaloblasts. Usually the liver is not involved.

It is of interest that the blood picture in this patient still shows a moderate anæmia four years after his splenectomy—as if some toxine, notwithstanding his splenectomy, was still affecting his hæmopoietic system. His last blood examination showed 4 per cent. eosinophilia, but stool examination was negative. He has had no further hemorrhages, although Mayo in an article published in 1921 stated that hemorrhages frequently continue after splenectomy and that in 8 out of 71 patients splenectomized for splenic anæmia, death resulted from subsequent hemorrhages in the next ten years after operation. There has also been no evidence of symptoms due to the liver cirrhosis which was marked four years ago at the time of operation.

#### CARCINOMA OF FLOOR OF MOUTH—RECURRENCE IN OPPOSITE SIDE OF THE NECK EIGHT YEARS AFTER OPERATION

DR. JOHN DOUGLAS presented a man, age sixty-one, who was admitted to St. Luke's Hospital, December 27, 1918. He then complained of a "sore" at the posterior border of the left edge of the tongue at the junction with the mucous membrane of the floor of the mouth. This had been present for four years. It had been treated with nitrate of silver several times, and burned with the electric cautery two or three times. Four months previously a piece had been excised for examination—findings unknown. Some enlarged glands were felt in the sub-maxillary region. December 30, 1918, the lingual artery was tied, the glands from the left side of the neck removed, and an area, consisting of the left border of the tongue, part of the floor of the mouth posteriorly, and the anterior pillar of the fauces, removed. The growth showed squamous-cell epithelioma. There was no carcinoma in the glands, but one was tuberculous. On April 8, 1919, he returned with a small mass of recurrence at the junction of the anterior pillar of the tongue. This was excised on April 9, 1919. He was then treated with the X-ray for the next three years and kept under observation.

## CARCINOMA OF STOMACH

In March, 1927, eight years after his first operation, he was examined and two good-sized nodes were felt in the right side of his neck. Careful examination of the throat and mouth showed nothing. His teeth had all been removed. March 22, 1927, a block dissection was done of the right side of the neck. Two of these glands were found to be carcinomatous.

This patient is shown as a late recurrence in the distant regional lymph-nodes eight years after operation without local recurrence; and to bring up a discussion of how extensive dissection of lymph-nodes should be in these growths in the tongue and in or about the mouth.

DR. ELLSWORTH ELIOT, JR., said that the fact that the glands are liable to become involved on the opposite side has been recognized for many years as attributable to crossed anastomosis. It is quite possible for metastasis to occur on the side of the neck not occupied by the original growth. The point of particular interest is the long interval that has elapsed since the operation and the development of secondary metastasis. Any interval of more than two or three years is very remarkable and an interval of seven years is worthy of comment. It merely goes to show that glandular involvement in carcinoma can remain quiescent for a considerable time, even in carcinoma of the tongue and floor of the mouth.

DOCTOR DOUGLAS rejoined that it is always advisable to remove the primary growth before removing the glands. He learned this in one case he operated on two or three years ago when he removed the glands first and the tongue a short time afterward. Three months afterward the patient had a palpable gland, which was carcinomatous, on the opposite side of the neck. A block dissection on this side was done and fortunately, up to the present time, there has been no sign of recurrence. Doctor Douglas wondered if it were possible to have a definite set of rules in these cases. He had always thought that when removing a growth in the mouth or on the lip the wise procedure was to remove all the regional glands on that side of the neck by bloc dissection at the same sitting, or at a subsequent sitting to the removal of the primary growth. If the pathological report shows that the glands are involved, it is wise to also remove all the glands on the opposite side. But in this case the glands on the side of the lesion were not involved and the man came back eight years later with recurrence on the opposite side, which would make this rule as valueless as many rules are.

## CARCINOMA OF STOMACH

DR. JOHN A. MCCREERY presented a man who was admitted to Bellevue Hospital in December, 1919, in his fiftieth year. He gave a history of epigastric pain of eighteen months' duration, pain coming on an hour after meals, relieved by carbohydrates, increased by taking heavy or greasy foods. There had been repeated free intervals of two or three weeks' duration. For six months before admission pain had been more continuous and vomiting had been a prominent factor, coming on an hour after eating anything but soft foods. He had lost thirty-five pounds in weight, and was unable to work because of loss of strength. On admission he was cachectic in appearance. There was a movable epigastric mass with a dilated stomach.

Test-meal showed a total acidity of 35, no free acid, no blood. X-ray was not taken.

At operation a pyloric tumor with apparent metastases to the glands of the omenta and to those overlying the pancreas was found, and a partial gastrectomy by the Billroth II method was performed. Examination showed an ulcer measuring 4 by 3.5 cm., the wall and floor of which showed infiltrating masses of epithelial cells, arranged in adenomatous strands, extending to the serous surface. The glands were not involved.

The man's convalescence was uneventful, and he has remained in good health without evidence of recurrence to the present time, seven years and four months after operation.

At operation he was regarded as an unfavorable case in view of his general condition and the extent of apparent glandular metastases.

He is shown as a case in which the size of the mass and the apparent involvement of the lymph-nodes made radical operation a somewhat questionable procedure. However, as Doctor Whipple pointed out in his discussion of Doctor St. John's recent paper on Carcinoma of Stomach, neither of these should be deciding factors in determining the advisability of a radical operation. It seems worth while to attempt the removal of any tumor which is localized to the stomach and to adjacent glands, and while the resulting cures are still few, one is justified in reporting them with the hope of impressing on the general practitioner the fact that carcinoma of the stomach is not always a hopeless condition.

DR. ALLEN O. WHIPPLE said that it was of some interest that in a series reported by Doctor St. John, last winter, of resection for carcinoma of the stomach, had the presence of a large mass with enlarged nodes taken to be metastases been looked upon as a contra-indication for resection and the patient allowed to go without radical operation, the results in patients surviving over five years would not have been as high as 15 per cent. All of these cases showed a large mass with enlarged lymph-nodes, and in one of the cases operated upon by the speaker, he very nearly gave it up as inoperable. The main point in determining whether or not the growth is to be resected is the presence or absence of metastasis in the liver and the extension of the growth into adjacent structures such as the pancreas. It is very difficult to judge on the table by the size of the growth whether or not it is carcinoma.

#### ULCER OF STOMACH

DR. JOHN A. MCCREERY presented a man of thirty-eight years, who was admitted to Bellevue Hospital, October, 1919, with a four-year history of gastric ulcer. At operation an ulcer was found high up on the lesser curvature. Resection did not seem feasible and the ulcer was subjected to cauterization and a gastro-enterostomy done. The symptoms were relieved but returned two and a half years later, lasting about a month and disappearing when some business trouble was straightened out. At this time an X-ray report of pre-pyloric ulcer was made but not confirmed at a subsequent examination. A test-meal at that time shows a total acid of 70, with 30 free acid, as compared with 25 total and no free immediately after operation. For the past five years aside from a short period of discomfort a year ago, he has been in good condition. X-ray taken a year ago showed no evidence of ulcer.



## SEPARATION OF LOWER FEMORAL EPIPHYSIS

In that he has had symptoms since operation, he cannot be considered a cure, but his relief has been very considerable, and he is presented as a case in which the Balfour operation has given a satisfactory result when resection was not possible.

DR. SETH M. MILLIKEN said that in 1919 he operated on a stomach and found a large ulcer on the posterior wall well over on the left side and adherent to the tail of the pancreas. The ulcer was carcinomatous macroscopically, had a crater measuring three-fourths of an inch and a total diameter of over one and a half inches. It seemed impossible to do anything but a gastro-enterostomy, which was performed. The patient made an uninterrupted recovery and gained 40 pounds in weight. Diagnosis made by X-ray before operation by Steiner was ulcer. The patient subsequently had no stomach symptoms until three years afterward, when she complained of pain and a good deal of bile after eating strawberries. She was advised to discontinue eating this fruit and thereafter had no further trouble. She died last summer from a cardiac condition. Doctor Milliken considered gastro-enterostomy has proven to be of great benefit in these high ulcers of the lesser curvature.

DOCTOR MCCREERY, in closing the discussion, referred to some work as yet unpublished that had been done at Bellevue by Doctor McWhorter. He had been studying autopsies of cases of malignant disease with particular reference to metastases. In 170 autopsies of cases of carcinoma of the stomach, 24 (14 per cent.) showed no evidence of metastasis. This would indicate that there was a very considerable percentage of cases in which a cure by operation might be hoped for and strengthened Doctor McCreery's belief that all cases without obvious metastases should be explored as in Doctor McWhorter's series some of the cases with large lesions in the stomach showed no extension beyond that organ.

## SEPARATION OF LOWER FEMORAL EPIPHYSIS

DR. JOHN A. MCCREERY presented a girl of thirteen, who was admitted to the First Surgical Division of Bellevue Hospital, December 24, 1926. Shortly before admission while in a crowd, she slipped and fell, and on getting up was unable to bear weight on right leg. No more accurate description of the injury could be obtained. On examination there was distortion of normal contour of knee region, with bony resistance in the popliteal space, suggesting posterior displacement of the lower end of the femur. There was 2 cm. shortening of the extremity. There was no evidence of injury to nerves or blood-vessels.

X-ray showed a dislocation of the lower femoral epiphysis, which lay with its upper surface in contact with the anterior surface of the lower end of the diaphysis.

Reduction was accomplished without difficulty by traction and flexion accompanied by direct pressure on the epiphysis. The dislocation tended to recur when the leg was straightened, so the knee was immobilized in acute flexion in a plaster cast.

This was kept on for five weeks. When removed active extension was

limited to 90 degrees, but this rapidly increased with active use, and function was complete when patient was discharged eight weeks after injury.

While dislocation of this epiphysis is described as a relatively common injury, one author quoted by Speed, speaking of it as the most common epiphyseal dislocation, it has been rather a rarity on the Bellevue Service, there having been only three cases admitted to the adult services in the past five years.

In Doctor Burdick's report of end results of fracture of the femur in children, read before this society in 1923, six cases are listed as lower epiphysis, but in none of these was there displacement, and there have been no traumatic cases with displacement on children's service since that report.

In the two cases not reported operation was necessary, either to obtain or to maintain reduction. In one of these there was 2 cm. shortening two years after the accident, while in the other no shortening was noted after eighteen months. In the present case it is too early to say whether or not growth will be interfered with, although it seems that there is generally some difference in growth after similar injuries.

The case is reported because it is a comparatively rare condition in the large number of traumatic cases admitted to Bellevue Hospital.

#### FISTULÆ OF SMALL AND LARGE INTESTINE

DR. ELLSWORTH ELIOT, JR., read a paper with the above title, for which see page 406.

DOCTOR ELIOT also presented a woman from whom eleven years ago a uterine tumor was removed by another surgeon. This was supposedly a myomectomy as menstruation continued to be normal.

Early in 1924 this woman was confined to bed for a period of six weeks by an attack of most severe pain, referred to the lower part of the abdomen, extending equally to either side from an area of maximum intensity just below the umbilicus. It was accompanied by chills and fever. On recovery, after an interval of about one month, she was again confined to bed for a period of six weeks by an attack marked by vomiting, severe pain in the lower rectum, and persistent diarrhœa. During the ultimate convalescence she was partially incapacitated with occasional attacks of pain and fever and a continuance of the rectal condition. In September, 1924, examination revealed a smooth elastic tumor in the lower abdomen, more marked on the right than on the left side which, on bimanual examination was found to be fixed in the pelvis. The overlying abdominal wall was prominent, reflecting the outline of the tumor, and was free from rigidity and marked sensitiveness.

On operation an extensive abscess, extending down into the pelvis more deeply on the right than on the left side, was opened. It was entirely walled off from the peritoneal cavity by dense adhesions that presented no line of cleavage. The uterus anteriorly was obscured in the thick wall of the abscess cavity.

Since the operation a sinus, changing its position from time to time, has persisted in the abdominal scar. In February, 1925, it was injected with bismuth by Doctor Stewart and was then found on "X-ray" to communicate with the cavity of the small intestine, although no gas or intestinal contents were noted until January, 1926, and then only in small, intermittent, amounts.

The discharge has steadily decreased, although in June, 1926, a secondary abscess developed on the right side and was opened by Doctor Mathews.

## FISTULÆ OF SMALL AND LARGE INTESTINE

Shortly after the first operation, a bloody discharge, preceding each menstrual period appeared, and continued for three days, to be followed by the usual vaginal flow for two days longer.

Latterly the sinus closed for the first time, remaining closed for a fortnight. The discharge is now at a minimum and contains no gas or intestinal contents. The abdominal scar becoming constantly more depressed is an indication of the ultimate healing of the sinus.

DR. ROBERT T. MORRIS said there were one or two points requiring emphasis. In the first place, if the inner opening of the fistulous tract is far enough away from the abdominal wall, plastic exudate will contract the walls of the fistula slowly but surely, so that spontaneous cure will occur as a rule. In cases in which there had been gangrene of the appendix in the early days of that surgery, the cæcum was sutured to the abdominal wall by some surgeons in order to ensure safe drainage. The opening was so near to the surface that walls of the short tract could not contract well. If the cæcum was carried away from the abdominal wall and exudate allowed to form about a drain that wall would contract and close the fistula spontaneously. Some will disagree with Doctor Eliot's idea of burying the stump of an appendix. The cæcum may balloon and cut out a constricting suture. Furthermore, such a suture makes an anæmic area that is vulnerable to infection for a few days. Another important recourse and one that should have been included in a discussion of this subject is the use of Beck's bismuth paste. The speaker recently had a case like the one described by Doctor Eliot with a large ovarian abscess. A Mikulicz's apron with packing had to be used and when that was removed a fistula followed. He did not know if it was from the ileum or the colon. A trial of Beck's paste was made, although this was not expected to suffice because there was discharge of mucus; but it was a success. One injection of Beck's paste was enough for that case. Beck's paste works remarkably in so many fistulas as well as in sinuses that it seemed to Doctor Morris one should ever have it in mind to be tried out at any rate.

DR. CHARLES GORDON HEYD concurred in Doctor Eliot's opinion that intestinal fistulæ had had insufficient study and a very doubtful classification. In his own personal experience he had been most impressed with four types of fistulæ: (1) Those occurring from perforation of a marginal ulcer into the colon; (2) those occurring between pelvic abscesses, tubes and the sigmoid; (3) those occurring between gall-bladder and duodenum, and (4) the common variety that occurs after gangrenous perforating appendicitis.

Nothing can be more devastating or formidable in surgery than the presence of a gastro-jejunal-colic fistula. The amount of surgery that may be necessary is quite extensive involving the closure of the stomach and jejunum and the resection of the colon. A case recently was admitted to the Post-Graduate Hospital, eight years after a no-loop gastro-enterostomy was performed. The patient's clinical history was interesting in that immediately after eating he had a colliquative diarrhœa, with pain entirely to the left of the midline and extending down into the hypochondrium. At operation

the anterior wall of the stomach about five cm. proximal to the pylorus was adherent to the under surface of the former laparotomy scar, with the result that there was a partial gastric angulation. In addition, the pylorus and duodenum were adherent to the under surface of the liver. The pylorus, however, was apparently patent. Adherent to the duodenum was an infected gall-bladder containing about twenty moderate-sized calculi. It is interesting to note the rather frequent development of gall-stones after gastric surgery, as certainly these stones were not present at the previous operation. Further support of the development of gall-stones after gastric surgery is the case that Doctor Heyd presented before this Society a year ago, in which it was demonstrated that gall-stones had formed in approximately eighty-five days, after a gastro-enterostomy. To revert to the patient under discussion, upon elevating the transverse colon upward and to the left, it was found that the gastro-enterostomy stoma was slightly contracted with the jejunum adherent to the transverse colon and a fistulous connection between stomach, jejunum and transverse colon. With the patient in the upright position the distal loop of the jejunum beyond the fistula formed an angulation which would have the effect of diverting almost the entire gastric contents into the transverse colon. Four distinct surgical procedures were necessary: (1) The taking down of the gastro-enterostomy; (2) closure of the gastric defect; (3) closure of the jejunal defect, and (4) resection of the transverse colon.

There is apparently no way of shortening the various procedures necessary in this type of case. The mortality is necessarily high. The technical difficulties of this type of fistula is only equaled in Doctor Heyd's experience by those that occur between the Fallopian tubes and the sigmoid. Interesting from the mechanical point of view are the fistulæ between duodenum and gall-bladder. In the last year he has had two such cases and in one the mechanism was that of a perfect ball valve. The patient would have an acute attack of cholecystitis, due to a large calculus within the gall-bladder, which would block the fistulous opening between gall-bladder and duodenum. After a variable period the stone would be dislocated and bile would be delivered from gall-bladder to duodenum with an immediate cessation of symptoms. At operation a single large calculus, five cm. in diameter, was obtained and little difficulty was experienced in closing the duodenal defect. Fistulous orifices in the duodenum heal, on the whole, kindly and technically are not of so great importance as are the fistulæ that occur from the opening of a jejunal stump following resection. Doctor Heyd's personal experience coincides exactly with that of Doctor Eliot in regard to fecal fistulæ in acute perforating appendicitis. He recalls but a very few cases where the appendix was amputated and the stump inverted that developed a fecal fistula of any importance. In fact, almost all of the fecal fistulæ due to appendicitis close spontaneously if left alone, unless there remains a portion of infected appendix, free fecoliths or secondary abscess between intestines and cæcum. It is usual to leave this type of fecal fistula without packing, and provide ample drainage with rubber tissue. It

## FISTULÆ OF SMALL AND LARGE INTESTINE

is surprising what large defects in cæcum will heal kindly and close except for the post-operative hernia. Doctor Heyd was inclined to believe that there were no set rules for the treatment of intestinal fistulæ and each case must be decided upon its merits.

DR. THEODORE DUNHAM reported the case which came under his care some years ago. A young woman upon whom another surgeon had, a few months previously, performed a laparotomy. All was well except for a sinus in the lower abdomen. A little pus exuded from the sinus, but there was no escape of fæces or gas. The sinus was tortuous and could not safely be explored by probe. With the hope of disinfecting the sinus and so bringing about healing, Doctor Dunham drew a solution of iodoform in ether into a syringe and injected it into the sinus. The ethereal solution left the syringe with a somewhat surprising readiness and vanished in the sinus. There was no local distress, but soon the patient spoke of feeling somewhat faint, her breath took on an odor of ether and she eructated gas smelling of ether. She did not lose consciousness, the feeling of faintness passed and in perhaps half an hour she was feeling herself again. This treatment made it clear that the sinus communicated with the intestine. The sequel was a happy and an interesting one. The sinus closed and remained healed without further treatment.

DR. WALTER M. BRICKNER said that in the case presented by Doctor Eliot, according to the history the patient had a myomectomy performed and some time afterward developed a pelvic abscess and then an intestinal fistula from which blood escaped at each menstrual epoch. Doctor Eliot gave no explanation of this phenomenon nor did he give a cause for the abscess. It occurred to the speaker that both could be explained by the hypothesis that at the time of the myomectomy the endometrium was surgically invaded and an endometrioma of the intestine resulted. An endometrioma will penetrate the tissues; in this case by perforating the intestine it could cause the pelvic abscess, and leave an intestinal fistula through which it would bleed at each menstrual period. If this did not take place then one must assume in Doctor Eliot's patient that the abdominal fistula communicates not only with the intestine, as shown by the röntgenograms after bismuth injection, but also with the uterus or a tube, and of this the röntgenograms give no suggestion.

DR. JOHN DOUGLAS said that the determination of the etiology of fistula arising from causes other than these due to the appendix is often very difficult and is, of course, of importance in deciding the nature of the treatment. Doctor Douglas had in mind two cases. One, a man, was admitted to Bellevue with several fistulæ; he had been operated on for double hernia and was finally brought to a hospital here in New York and operated on for fecal fistula, but unsuccessfully. He was then transferred to Bellevue. He had two or three openings in the abdominal wall and another perineal opening which leaked fæces. His condition was dreadful and the case looked hopeless, but it was decided to operate. After doing a cæcostomy an exploratory was done and an old strangulated femoral hernia was found; part of the gut

wall was fixed in the femoral ring and had allowed feces to leak from there. Two other openings were found in the sigmoid. Resection of the intestine with closure of the cæcostomy resulted in the man getting well. Another case was that of a man operated on after a gunshot wound of the abdomen in another city. He was sent to Bellevue with obstruction of the descending colon and was operated on by one of the staff. Resection seeming impossible and as obstruction was present, an ileo-sigmoidostomy was done. He had a stormy convalescence and shortly afterward developed a fistula. Most of the intestinal contents escaped and the abdominal wall was badly eroded and bismuth enemata immediately came through this fistula, so the assumption was that the ileo-sigmoidostomy had broken down. Finally, it seemed that something had to be done, and on dissecting the fistula it was found that a loop of the small intestine had become pinched in the abdominal wound and all that was necessary to cure him was to sew up a little hole in the small intestine. These two cases were cited to show the different possibilities one has to face in closing a fecal fistula.

DR. SEWARD ERDMAN said that the formation of a combined external fistula, communicating both with intestines and uterus, somewhat similar to Doctor Eliot's case, had occurred at the New York Hospital. The patient was a colored woman, operated upon for a large ruptured tubo-ovarian pelvic abscess, and drained both abdominally and by vagina. Death occurred after three weeks and post-mortem examination revealed a fistulous tract which communicated with the ileum and with the uterine cavity. Whether this was due to infection and sloughing of the uterine wall, or to pressure of drains was never decided. Had she lived, it is possible that menstruation might have appeared through this fistula.

DR. DEWITT STETTEN thought that drainage should be emphasized as an important factor in the etiology of fecal fistula. It has always been his custom in abdominal drainage to use a cigarette drain consisting of a rubber dam tube with a strip of gauze running through. He has always felt that this type of drain was the most efficient and at the same time the most innocuous. In the past few years he has, however, had two cases in which he was sure the drains were the cause of a resultant fecal fistula which developed after their removal. He believes that the combination of damage to the intestinal wall from suppuration and erosion, from even a soft cigarette drain, causes the fistula, but, he asks, how can this be avoided? He does not believe in removing the drains too soon, feeling that they should be left in place long enough so that a definite sinus tract can form and so that subsequent retention will be avoided. His practice has been not to touch the drains for at least a week, unless there is some special indication for earlier removal. He admitted that it was quite possible that in the two cases cited, the drains may have been left in a trifle too long for those particular cases.

DR. HUGH AUCHINCLOSS said that there are so many causes for these fistulae that it is hard to analyze them. One thing that has helped in several

## FISTULÆ OF SMALL AND LARGE INTESTINE

cases in the treatment is suction; he was in despair regarding one very sick case with a small intestinal fistula high up and happening to see a flat soft sea sponge in a druggist's window conceived the idea of making a hole in the middle, using this for the suction tube and utilizing it to take up the excess fluid as it gushed forth. The skin had become excoriated in forty-eight hours. The sponge was a great help in keeping the intestinal contents away from the skin. Drying the wound was another great help by means of electric light lamps. Another point about which Doctor Auchincloss wished to speak was the occurrence of fistula following the division of adhesions. These, if of any length of standing, are much stronger than the intestinal walls and trying to separate them by force will result in trouble. The adhesions should be divided by sharp dissection first with a knife or scissors, and blunt dissection subsequently and only with greatest gentleness.

DR. FREDERIC W. BANCROFT said that one of the means of preventing fecal fistula is drainage of secondary pelvic abscess following appendicitis either through the cul-de-sac or through the rectum. If an abdominal approach is made, however, the adhesions of the intestines are sometimes very dense and in attempting to free them frequently the bowel wall is injured and a fistula results.

He has used drainage through the anterior rectal wall for pelvic abscess in a considerable number of cases and has seen no ill results from this procedure. It is very easy to do and needs only a primary anæsthesia.

The tube is usually removed about the fifth day, and in only one case has he seen a secondary accumulation of pus following its removal.

DOCTOR ELIOT said in answer to Doctor Morris regarding the use of Beck's paste, he had no opinion because he had never tried it. But he did believe in the efficacy of the injection of stimulating solutions. The subject is indeed one with many different angles. As regards duodenal fistula, he quoted the writer of a recently published essay who collected a number of cases, about seven in all, of which five healed spontaneously. In many fistulæ the tendency is to heal spontaneously. Doctor Morris had stated that without the use of the purse-string suture he had never seen a case of fecal fistulæ. The late Doctor Weir was in the habit of using plain catgut in the ligation of gangrenous and infected appendices without any accident. Yet the speaker has notes of half a dozen cases of fecal fistula that followed that method of treatment. Since 1902 he had buried the stump with a purse-string suture of absorbable material and the incidence of fecal fistula had been very much less. Where there has been occasion later to open the peritoneal cavity for another condition it has proved difficult to identify the site of the appendix stump. The purse-string suture has never done any harm, in the speaker's experience. Answering Doctor Bancroft's comment, Doctor Eliot said he had never had any experience in opening a pelvic abscess by rectum. The German school did that about twenty-five to thirty years ago and reported success in their periodicals. The speaker did not consider it a difficult matter to orient and drain a pelvic abscess without harm

to the sigmoid through the suprapubic route with satisfactory results. Regarding drainage, Doctor Eliot said he had given up using the cigarette drain because it had blocked discharge and had substituted a flexible rubber tube with a strip of gauze running through it. This drain is taken out at the end of the second day and a fresh one introduced. Daily replacing of the tube follows and at the end of a week its use may frequently be suspended. The period of abdominal drainage should be curtailed as far as possible. In regard to Doctor Stetten's experience, the continued use of a cigarette drain for a week might predispose to the development of a fistula, especially if it were near the line of visceral suture. In all these fistulae the most difficult one to deal with is a fistula due to a gunshot wound of the large intestine; the speaker had tried to emphasize, in discussing radical treatment, that one should do the anastomosis as close to the site of the fistula as possible. Ileo-sigmoidostomy is simple but an anastomosis between the transverse colon and the sigmoid, if feasible, is much preferable. The resection of the fistulous tract after the anastomosis has been found to give generally good results.



# BRIEF COMMUNICATIONS

## ILEO-CÆCAL CYSTS

CYSTS of the intestinal wall at the ileo-cæcal angle, by reason of a distinct pathology and a definite symptomatology, merit a place in surgical literature. A consideration of the few cases that have been reported leads to the conclusion that the rarity of the condition has been the reason for its lack of recognition as a surgical entity.

Frankel, in 1882, reported an autopsy on an infant that died after three days of acute intestinal obstruction and described clearly a cyst in the wall of the intestine which spanned the ileo-cæcal valve and was the cause of death. In 1900, Sprengel reported a case in a girl of fifteen who had experienced obstruction symptoms for four years and was submitted to operation during an acute period with a similar finding. Sporadic cases to a total of not more than ten have reached the literature up to the present, all exhibiting a constancy of location, and a symptomatology of acute obstruction which, in a majority of cases, was diagnosed as intussusception. A typical case history, and one that corresponds to our own, is that of the case of G. W. G. Bryan: An infant with acute intestinal obstruction and a right lumbar tumor, gave an operative finding of an antimesenteric cyst of the ileum, the size of a tangerine, with one-third of the cyst in the wall of the cæcum and the edges of the ileo-cæcal orifice constricting the cyst. Being judged not removable by dissection, it was treated by marsupialization and at a later stage resection. A muscle layer was demonstrated in the outer wall.

Sir Arthur Keith, in studies upon a preparation of a full term still-born

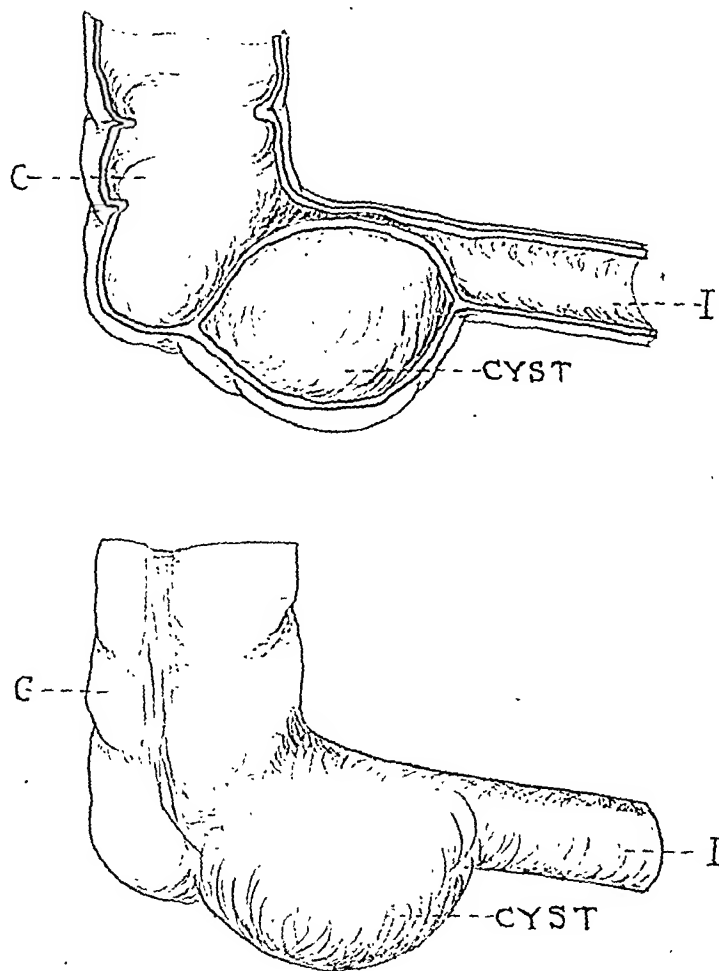


FIG. 1. Ileo-cæcal cysts.

## BRIEF COMMUNICATIONS

child in the Royal College of Surgeons Museum, and one other case, that reported by H. F. MacAuley, found a mucous lining and a muscular coat and concluded that these cysts are embryonic extensions from the bowel, with a predilection for ileo-cæcal location which he was at loss to explain. The view, that these structures arise from vacuoles or diverticula in the developmental period and are later cut off from communication with the lumen of the intestine, has been reviewed thoroughly by T. A. Shallow.

CASE REPORT.—No. 37,610, Rochester General Hospital. E. C., female, age seven months, experienced an acute onset, three hours before admission, of pallor, vomiting and crying apparently due to pain. Throughout pre-operative period there were short periods of remission followed promptly by sharp recurrence. There was no other history except that the child had been very constipated from birth and that a smaller stool than usual had been observed twelve hours pre-admission. Repeated enemata brought no relief, blood or fecal matter. Physical examination showed only a tense, tender, movable tumor in right lower abdomen, which was distinctly "sausage-shaped" and measured about one by two inches. Operation under a confident diagnosis of intussusception disclosed a discrete cystic formation in the anti-mesenteric intestinal wall extending across the ileo-cæcal junction and evidently causing obstruction. The cyst was opened, a quantity of thin colorless fluid evacuated and lost and the lining membrane removed as completely as possible. Since the cystic structure could not be removed without jeopardizing intestinal wall, the outer layer was trimmed to permit of being sutured down in exact approximation and a normal appendix removed. Recovery was prompt and uneventful, and there has been no complaint in the ensuing six months.

The pathological report stated: Specimen shows a mucosa of cylindrical epithelium, flattened as if there had been fluid under tension, set directly against a muscle layer showing both circular and longitudinal fibres. Possibly this is a diverticulum which has amputated itself and become cystic. (F. B. Mallory.)

### COMMENT

Without attempting to express a full knowledge of the significance of ileo-cæcal cyst, it is of interest to note that the few cases observed exhibit a constancy of site, a tendency to production of obstruction symptoms, usually during the first year of life, and a perfect simulation of intussusception.

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## FRACTURE HELD BY LANE'S PLATES

### NECROPSY OF HEALED FRACTURE OF FOREARM HELD BY LANE'S PLATES

In so large a collection of human anatomy as exists in the Hamann Museum of Western Reserve University, there must necessarily be a fund of material upon which can be studied the results of surgical treatment. As a rule such material is of benefit to the local medical community alone. It has seemed to us that this material should be placed at the disposal of a larger public and we propose therefore to publish illustrated notes of specimens committed to our care especially such as demonstrate immediate or end results of disease, injury and treatment, which, in the usual course of events, cannot be adequately studied in the clinic. One such article has already been sent to the *ANNALS OF SURGERY*,\* and our immediate purpose is to add thereto a second dealing with Lane's plates.

The individual here discussed is a white male (Number 973), of twenty-eight years, whose clinical record indeed gives no informa-



FIG. 1.—Bones of forearms, No. 973, white, male, twenty-eight years. Lane's plates on right radius and ulna. Note the perfect union and position of fragments, the slight exostosis on radius, the small exuberant callus on ulna and the supporting loop of silver wire with its erosion of the bone.

\* Todd, T. W., and Iler, D. H.: 1927. The Immediate Appearance of Fracture of the Lower Extremity of the Radius. *ANNALS OF SURGERY*, vol. lxxxv, p. 956.

tion bearing upon the lesion but who exhibits an old healed fracture of the right radius and ulna. An excellent result has been attained by the use of

Lane's plates. Apposition and position of fragments are perfect. No limitation of movement resulted from the injury. Very slight exostosis occurred on the radius alone and permanent exuberant external callus is found in one place only on the ulna. The marrow cavity was not completely restored on either bone. How long previous to death the operation occurred we cannot say, but the skin scar was not adherent to the deeper tissues and hence we may estimate a minimum elapse of five years.

When the plates were fastened into place on the ulna the screws did not hold quite securely and union was strengthened by a silver wire loop around the fragments. Under this loop a limited erosion of bone has taken place (Fig. 2).

The radiograms (Figs. 1 and 2) show the screws still holding firmly; the threads are not surrounded by any erosion of bone though their presence may well

FIG. 2.—Later radiogram of right radius and ulna. Note the secure hold of the screws on the bone tissue, incomplete restoration of marrow cavity on both bones, the erosion by silver wire and exuberant callus on ulna, and the small exostosis on radius.

be the cause of incomplete restoration of the marrow cavity. The ulnar screws have apparently secured a firmer hold than at date of operation itself.

In spite of immobility perfect union has taken place between the fragments. We have already presented evidence against the limiting action of

immobility upon bone union and it is unnecessary to discuss the subject further, but it should be mentioned that we hold mobility of fragments to assist in securing union by its action in producing a surrounding traumatic periostitis rather than by any influence upon the fracture faces which indeed we find to be reduced in vitality as the result of mobility.

The skin scar shows that this injury was a simple fracture; there is no indication of suppuration or drainage. The operation was therefore done in a surgically clean field under the best conditions in a young individual in whom bone repair was still active.

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### LARGE GUMMA OF THE ABDOMINAL WALL, SIMULATING AN INTRA-ABDOMINAL TUMOR

That syphilitic lesions may involve the various muscles of the body, has long been known. Theodosius<sup>1</sup> recognized this condition as long ago as 1553. Four different types of muscular disturbance arising from syphilis have been enumerated; namely, myalgia, diffuse syphilitic myositis, progressive loss of muscular tone and power, and gummata.

The muscles that most frequently become the seat of gummata are those of the tongue. However, these lesions may occur in other muscles, including the triceps, biceps, gastrocnemius, pectoralis major, sterno-cleido-mastoid, masseter, flexors of the forearm, and the abdominal muscles. Hazen<sup>2</sup> cites a case in which nearly all the muscles of the body were infiltrated with miliary gummata. Such muscles become hard and develop contractures.

While gummata of the abdominal wall do undoubtedly occur, they rarely reach such size as to be confused with an intra-abdominal newgrowth, as in the case we are reporting. After a careful survey of the literature, we have been able to find only three similar cases.

Hunter,<sup>3</sup> in 1905, reported the case of a single woman, aged twenty-three, who noticed an almost painless, gradually increasing swelling about 4 inches in diameter in the left lower quadrant of the abdomen, involving the abdominal wall midway between the umbilicus and the left iliac spine. It was a hard, firm, irregularly rounded mass. The patient denied syphilis and there were no evidences of the disease on physical examination. At operation the cut tissues of the abdominal wall were found to be hard and infiltrated. When a second operation was performed, a typical gumma was found beneath the skin and involving the fascia. Surrounding it, there was a yellowish area of dense infiltration having the consistency of custard and an odor suggestive of degeneration. The muscles and subperitoneal tissue were also infiltrated with dense connective tissue containing areas of degeneration. Under treatment with mercury and potassium iodide, there was rapid improvement and the swelling and induration soon disappeared.

Levin,<sup>4</sup> in 1922, reported the case of a man, aged seventy-four, who complained of loss of weight, epigastric and abdominal pain, and digestive

symptoms. A mass was found in the abdomen and two gastric analyses showed complete achylia gastrica. At first, it seemed to be a case of carcinoma of the stomach; but röntgenologic study proved that the growth had no connection with the stomach, which was normal in outline. Then a small, indurated lesion on the right forearm was found, which on pathologic examination proved to be a gumma. The Wassermann reaction was strongly positive. Under treatment with arsphenamine and mercury rubs, the patient improved rapidly and the abdominal mass disappeared almost completely. Under the circumstances, it is reasonable to suppose that the growth was a gumma of the abdominal wall, simulating an intra-abdominal neoplasm.

Férey,<sup>5</sup> in 1925, published the case of a Greek man, aged thirty-five, known to be syphilitic, who showed distinct prominences in the lower part of the abdominal wall. The entire region below the level of the umbilicus was filled with a hard, nodular, sharply outlined, almost painless, slightly movable mass, corresponding in width to the two recti muscles. On alternate contraction and relaxation of the muscles of the abdominal wall, the position of the tumor remained unchanged; therefore, it was interpreted as being a parietal, extraperitoneal growth. At operation, the abdominal wall was found to be infiltrated with hard, brownish cicatricial tissue, about 2 cm. thick. The underlying peritoneum was smooth. Microscopic examination of a piece of tissue removed for biopsy showed it to consist of slightly changed muscle fibres, separated by strands of sclerotic tissue; there were numerous vessels with thickened walls, surrounded by lymphocytic and plasmocytic infiltration. After eight days' treatment with mercury and arsphenamine suppositories, the tumor became softer. At the end of four weeks of antisyphilitic treatment, the growth had practically disappeared. Férey comments on the rarity of the condition, stating that he could find no analogous case in the literature. It would seem, however, that the cases reported by Hunter and by Levin were essentially similar, as is our own.

From a consideration of the cases cited, it is apparent that the presence of a gumma involving the rectus or other abdominal muscles may give rise to confusion as to whether the growth is inside the abdominal cavity or merely in the abdominal wall. Leas<sup>6</sup> has observed a similar resemblance between myositis of the rectus abdominis muscles and acute intra-abdominal conditions, reporting two cases in which acute appendicitis and acute cholecystitis, respectively, were simulated by rheumatic myositis of the recti muscles.

CASE.—Mrs. R. N., aged sixty-four, housewife, was admitted to the Lenox Hill Hospital, November 29, 1926, complaining of sharp pain in the left lower abdomen of five weeks' duration. She had been married twice, but had only a stillbirth by her first husband and no pregnancies by the second. The menopause had taken place twelve years previously.

The pain was first noticed about October 25, while the patient was reaching upward. Sometimes it felt like the pricking of a needle; at other times, it was like a dull ache, such as follows a severe blow. On occasions it would be severe enough to keep her awake, and sometimes it radiated to the left loin.

The left lower quadrant of the abdomen was found to contain a very large, smooth,

## GUMMA SIMULATING INTRA-ABDOMINAL TUMOR

extremely tender mass, which felt elastic and was fairly movable. The rest of the abdomen was slightly tender but not rigid.

On vaginal examination, the mass seemed to lie in the abdominal cavity. It was about the size of a large melon, round, rather soft, and movable. It extended upward from about 2 cm. above the symphysis pubis. The surface felt smooth. On palpation the growth proved to be quite tender. It seemed to be attached at its base either to the uterus or the adnexa, but this lower attachment was difficult to make out. The cervix was smooth, hard and irregular. The whole uterus was of moderate size, movable, and tender over the left fornix. The right adnexa appeared normal.

An X-ray examination, after the ingestion of the opaque meal, was entirely negative. The routine blood Wassermann test was negative. Except for an alkaline reaction and a moderate number of pus cells, the urine was negative. The white blood-cell count was 11,000; there were 78 per cent. polymorphonuclears, 17 per cent. small lymphocytes, and 5 per cent. large lymphocytes.

Before operation, the most likely cause of the tumor was believed to be an ovarian cyst, a large pedunculated uterine fibromyoma, or an omental cyst.

Laparotomy was performed on December 7. A longitudinal incision was made between the symphysis pubis and the umbilicus. When the peritoneal cavity was opened, no tumor was seen; the growth was found to occupy the abdominal wall instead. It was located extraperitoneally within the left side of the abdominal wall, lying between the peritoneum and the muscle and also involving the muscle to a certain extent. A small portion of intestinal loop and omentum was adherent to the site of the inflammatory condition. These adhesions were not disturbed.

On further investigation, the inflammatory condition of the abdominal wall was found to be flattened and to occupy an area about 5 inches in diameter. Several incisions were made. In each case, similar conditions were found; namely, highly inflammatory tissue. At one spot, there was an escape of some sero-sanguineous fluid. Two pieces of tissue were excised for microscopic examination.

The peritoneum was closed with running chromic catgut sutures, the area of the growth in the abdominal wall packed with iodoform gauze, and the abdomen closed in three layers.

*Pathologic Examination.*—The tissue removed at operation consisted of three small, irregular masses bearing no resemblance to the gross structure of any viscus. Microscopically, one of the fragments was seen to be made up of inflammatory fat tissue, split up into lobules by dense fibrous trabeculae. The other two fragments consisted largely of compact bundles of fibrous tissue containing islands of fat tissue. On the surface, one of the fragments was covered with a thick layer of suppurating granulation tissue. A more diffuse area of suppuration, not limited by a membrane, was noted in the fibrotic fat tissue. *Pathologic Diagnosis.*—Chronic suppurative inflammation.

Following the operation, there was a profuse purulent discharge from the inflammatory abdominal tissue. For several days, the temperature fluctuated between 103° and 104° F.; the pulse, between 110 and 120. On December 10, the temperature and pulse dropped to normal.

On December 20, an examination of the cerebrospinal fluid was made. It contained 40 cells per cu. mm., all of them lymphocytes; globulin and reducing substances were negative; the Wassermann reaction was strongly positive.

Beginning December 22, the patient received vigorous antisyphilitic treatment with neoarsphenamine and mercury salicylate intramuscularly. On January 16, sulpharsphenamine was substituted for neoarsphenamine, as the patient did not stand the latter preparation well. This treatment was continued until the date of discharge on February 9.

On January 17, the patient stated that she no longer suffered from the severe abdominal pain. The infiltrated mass in the abdominal wall was only half its former size. There was still a persistent sinus from the abdominal wound.

## BRIEF COMMUNICATIONS

On January 29, the mass in the abdominal wall was only about 2 inches in diameter. There were still two sinuses in the upper and lower openings of the abdominal wound, respectively, each about  $2\frac{1}{2}$  inches long.

Under the intensive treatment, signs of mercurialism developed; therefore, mercury treatment was discontinued on January 31. By February 9 the salivation had disappeared and it was possible to resume vigorous antisyphilitic measures. The pseudo-tumor in the abdominal wall had practically disappeared; that is, it measured only 1 cm. in diameter and was no longer painful. The sinuses were closed. The patient was discharged but advised to return to the dispensary for treatment.

Large gumma of the abdominal wall is so rare a condition as to be easily mistaken for an intra-abdominal tumor. In all four cases here cited, the resemblance to a growth within the abdominal cavity was very great. In Levin's case, the diagnosis of carcinoma of the stomach first suggested itself; in our own case, an ovarian cyst or a large pedunculated fibromyoma.

A positive Wassermann reaction is, of course, of great help in the diagnosis; but the therapeutic test, that is the rapid disappearance of the growth under antisyphilitic treatment, is of still greater value, as was proved by the experiences in all four cases. Evidences found on general examination or the history may suggest a syphilitic origin of the abdominal growth. In Levin's case, a small gumma was found on the right forearm; in Férey's case, there was a frank history of insufficiently treated syphilis. In our own case, the finding of small, unequal, irregular and stiff pupils and the absence of knee-jerks led to the final diagnosis.

The growth appears to take origin from the muscles of the abdominal wall, spreading to involve the fascia and sometimes the skin. Gummata localized in the various muscles of the body are not exceedingly rare; but usually they are small and multiple, and rarely do they become large enough to simulate an intra-abdominal neoplasm.

The results of antisyphilitic treatment are very satisfactory. Within a period of weeks, the enormous growth in the abdominal wall melts away and finally disappears completely. The courses of treatment should, of course, be continued long after the symptoms have disappeared and be guided by their influence on the Wassermann reaction.

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## MULTIPLE INTRAPERITONEAL CONDITIONS

### EFFECT OF SECTION OF THE VAGO-SYMPATHETIC NERVES OF THE STOMACH UPON THE SECRETION OF HYDRO-CHLORIC ACID IN THE GASTRIC JUICE

In the ANNALS OF SURGERY of May, 1926, was published an article by Dr. Benedetto Schiassi, of Modena, on the rôle of the pyloric-duodenal nerve supply in surgery of duodenal ulcer. Following the work of Professor Schiassi, his colleague in the same clinic, Professor Foa, instituted a series of researches for observing the modifications of hydrochloric acid secretions of the stomach following resection of the different nerve elements of the stomach after the method of Schiassi.

The first series of researches were performed upon men. Two patients that had been operated by Professor Schiassi himself with the resection of the nerve elements of the pylorus and branches of the vagus, the latter on the highest part of the small curvature of the stomach. Gastro-enterostomy was not performed.

The hydrochloric acid value that was found after the operation was, in relation with that found previously, notably diminished after a year and half.

The second series of researches were executed upon dogs. In certain of these animals Doctor Foa has resected the pyloric nerves, that is to say he has produced a sympathetic discontinuity. The results demonstrate a great increase of hydrochloric secretion after the operation. In other animals he sectioned the branches of the vagus with results that demonstrate a great diminution of the hydrochloric acid secretion. In a third group of animals he performed at the same time the resection of the pyloric nerves and branches of the vagus at the small curvature, noticing a small diminution of the hydrochloric acid secretion.

The researches of Doctor Foa seem to be very interesting and important because the results obtained in men and those resulting from the experiences upon animals are in perfect accord and they prove that in the surgical intervention upon the nerves of the stomach after the methods of Professor Schiassi it is possible to influence at will the hydrochloric acid secretion of the stomach.

Doctor Foa following his experiments concludes that in men, when due to nervous causes there are great and persistent alterations of the hydrochloric acid secretion, surgery can intervene to obtain a permanent equilibrium of the secretion. The report in full may be found in the *Gazzetta Internat. Medico-chirurgica*, May 15, 1927.

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### A SINGLE INCISION FOR MULTIPLE INTRAPERITONEAL CONDITIONS COMPLICATING ABDOMINAL HERNIA

Actually there are a large number of people who after a satisfactory operation for hernia later have to come back for operation for appendicitis or other abdominal disease, to say nothing of the much larger number who continue to suffer the indigestion and the recurrent pains of chronic

disease of the appendix or some other intra-abdominal pathology which could have been cured at the same time the hernia was operated upon.

The simple procedure of splitting the muscles about an inch above the internal inguinal canal and inspecting the organs, shows great frequency of associated disease of the appendix and pelvic organs, permits their simultaneous cure, and gives the ideal method of approach to a hernial sac for removal. No one now imagines appendectomy adds danger of wound infection. My own experience in operating upon more than twelve hundred cases of abdominal hernia has been that in approximately 60 per cent. of right inguinal hernia in adults, I have removed through the same incision diseased appendices, and in more than 4 per cent. of nearly two thousand people operated upon for appendicitis, abdominal hernia has been operated upon through the same incision. In women, approximately 3 per cent. of between fifteen hundred and two thousand operated upon for pelvic disease, abdominal hernia was present; and of the women who came primarily for hernia, approximately 80 per cent. had also pathology of the pelvic organs. These figures are lower than the actual frequency of association owing to the fact that in many of the earlier cases, associated diseases were overlooked.

The point to be emphasized is that it is highly proper that when a patient is to be operated on for hernia, appendicitis or pelvic disease, the whole abdomen should be examined before operation and the incision should permit a thorough exploration of the region in the abdomen upon which the patient is to be operated. For years I have advocated the removal of inguinal and femoral hernia through an incision into the abdominal cavity an inch above the neck of the hernia.\* This incision gives great satisfaction in securing an easy and complete enucleation of the hernial sac in full view and without danger to neighboring structures (vas deferens, vessels and bladder) and above all with complete and permanent cure of the hernia. Through this incision for hernia of the right side, the appendix is easily removed unless very densely adherent to a cæcum located nearly as high as the umbilicus; and on either side any disease of the tube and ovary is accessible.

My plea now is for a routine adoption of some such incision as this for the discovery and removal of the sac of hernia, the appendix and co-incidental pathology of the female pelvic organs.

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## REPAIR OF HERNIA OF THE DIAPHRAGM\*

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HERNIA of the diaphragm is of interest to surgeons and clinicians alike, partly because of the spectacular event so often connected with its acquirement or its repair, and partly because of its rarity. Hedblom, in 1924, was able to find records of only 359 cases reviewed in the literature. To these he added nineteen cases from the Mayo Clinic bringing the total to 378. Since this report, eight other cases have been observed in the Clinic, making twenty-seven in all. It is probable that the total number of reported cases would represent only approximately half of the actual number, since the first two cases on record were reported by Ambroise Paré in 1610.

Hernias of the diaphragm are classified as congenital, acquired, traumatic and indeterminate. Thirty-seven cases were of congenital origin from defects in the closure of the diaphragm separating the thorax from the abdomen. This thin muscular structure is aponeurotic throughout its periphery, or tendinous throughout its centre, and with muscular contraction the dome of the diaphragm is brought down in the fixed chest, like a piston in a gas engine moving downward from the inrush of the air into the lung within the cylinder. One of the causes of such hernia in adults is rupture from a crushing injury, the body being forcibly depressed between the knees as from the caving in of dirt banks on the backs of ditch diggers. As I recall my early practice, some of which was in obstetrics, I well remember the efforts made to stimulate that first respiration in apparently stillborn or dead children. The efforts were usually successful, yet it is easily understood how rupture of the diaphragm could occur from such vigorous manipulations and how later it might appear that the rupture was of congenital origin, since the condition did not immediately cause symptoms.

From such efforts at resuscitation, complete atrophy of one or two of the leaves of tissue that form the diaphragm might then occur and the defect would appear to be of congenital origin, although occurring at birth. It is of interest that in some of the cases considered congenital no history of trauma during life sufficient to cause the defect has been recorded, a number of patients living to middle age and some to old age before symptoms develop. The most common traumatic causes of diaphragmatic hernia are stab wounds through the lower ribs, passing through the pleura and diaphragm; a con-

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\* Read before the American Surgical Association, May 12, 1927.

siderable percentage of such cases have been followed by immediate prolapse of the omentum, and this has led to many operative closures of hernia of the diaphragm by exposure on the upper or thoracic side through the chest wall. Gunshot wounds have been the cause of a number of such hernias. Hedblom attributed war injuries as the cause in 127 of the 378 cases.

Only a few hernias have been noted as occurring at the site of the natural openings. Undoubtedly in many cases a weak point may occur on the left side of the oesophageal site in the diaphragm which permits the fundus of the stomach to flop back and forth through this opening without actually becoming a free hernia. The aponeurotic or fibrous structure of the central portion of the diaphragm is so thin and stretched at this point that it is difficult to remedy the condition. Although I have noticed the condition I have not felt that the symptoms were serious enough to warrant surgical intervention. On the right side the diaphragm is so well protected by the liver that it is seldom injured, and yet a few cases are reported with prolapse of the omentum into the right side of the chest. These openings may be small or they may be very large; the lung is contracted and, in the long-standing cases, fixed in the upper part of the chest. It is surprising how much of the contents of the abdomen can pass into the left side of the chest: the stomach, upper part of the duodenum, most of the colon and practically all of the small intestine and the spleen. The symptoms are vague in many cases, unless there are attacks of obstruction. In approximately one-third of the cases reported operation has been performed for intestinal obstruction and the condition found. Others have been recognized through careful examination which is greatly aided usually by röntgenograms with the barium meal or with barium injected into the colon. The symptoms, then, over several months or several years may be: retracted abdomen, bulging chest, pain, vomiting, tympany of the lower part of the thorax and occasional dulness with displacement of the heart to the right. Often the clinical data are practically negative. Small openings have led to partial hernia of the intestine with incomplete obstruction and perforation into the chest with empyema.

In a case now under my observation (that of an adult with a small hernia in the diaphragm) a knuckle of the side of an intestine came through and strangulated; adhesions formed and perforation with incomplete obstruction occurred. The resulting empyema cavity was drained, and later a larger incision revealed the condition. An attempt at closure on the thoracic side failed and the cavity is still draining. This is a serious condition and the operation will be serious as it will mean local sepsis at least and drainage of the abdominal cavity and closure of an inflamed septic hernial opening into the empyema cavity.

Patients with diaphragmatic hernia are afflicted with all degrees of the complaint from slight to the extreme type with total disability and much suffering. Their condition may aid in determining the justifiable risk the surgeon should assume in operative treatment if the hernia has been diag-

## REPAIR OF HERNIA OF THE DIAPHRAGM

nosed previously or has been found during abdominal operation or exploration.

### TECHNIC OF OPERATION

If the condition has been diagnosed, it will probably be best to perform the operation by opening the upper part of the abdomen with an oblique incision along the left costal margin. In special instances it may be advisable first to open the thorax, but for all practical purposes the abdominal route gives the best control and, theoretically, more should be accomplished from the abdominal side. In a

few instances the operative procedures are carried out from above; in a greater number they have been carried out from below, and in certain others both regions are exposed. It is surprising what an amount of force is exerted by respiratory effort to suck the abdominal contents through the hernial opening. The removal of a part of the contents of a large hernial sack by drawing it back into the abdomen can be accom-

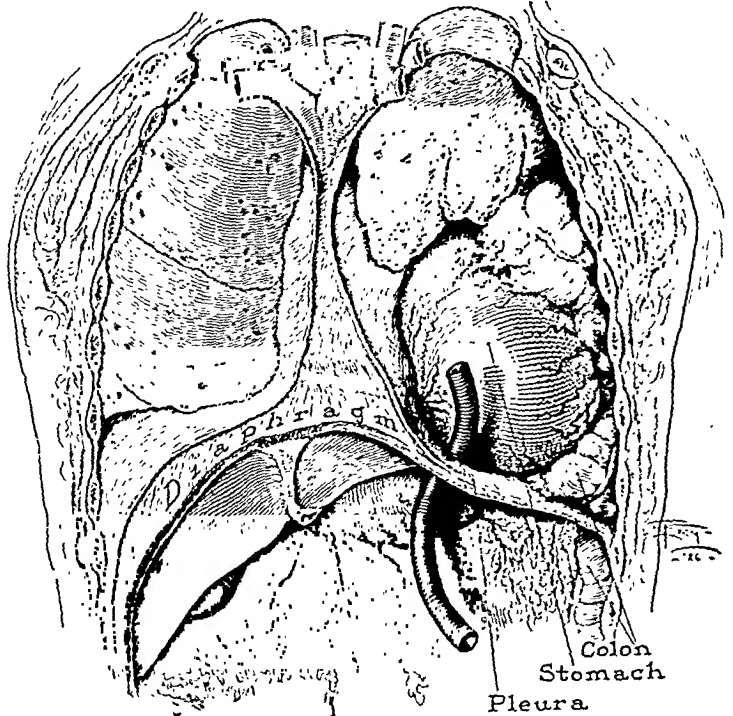


FIG. 1.—Hernia of the diaphragm; rubber tube passed into pleural cavity to relieve vacuum.

plished without difficulty, but very soon the suction power of a vacuum is made apparent by the difficulty experienced in withdrawing the remainder; the sac appears to be fixed by adhesion. Certain operators have been led to open the chest, the entrance of air permitting the withdrawal of the hernial mass into the abdomen.

In operating through the abdomen I found that a moderately stiff rubber tube passed into the chest along with the hernia before retraction is made to permit air to enter, minimizes this tremendous suction and the stomach and bowels may be withdrawn without difficulty. (Illustration.) In fact on the value of this device I based my choice of a subject for discussion at this meeting. I believe we should have no hesitation in dividing attached parts of the omentum that are firmly adherent within the chest. The abdominal contents must be well packed off and controlled or they will endeavor again to enter the opening during operative procedures. The opening can be closed in one suture line with chromic catgut and a double or running buttonhole stitch. Balfour found (in a case of railroad injury in 1911 in which he operated in 1915) that half of the opening could be closed, then the remain-

ing half closed at right angles to it, like a capital T. It is not advisable to use abdominal tissue, the wall of the stomach for example, for protection by suturing it to each side of the opening since the stomach will gradually dilate the opening and more and more of the hernial sac will pass into the chest. Quite large openings may be closed by enucleation or division of the lower ribs to permit drawing in of the peripheral attachment of the muscular diaphragm. In operations of expediency the results have been good; if there is strangulation the success of the operation depends, as in all cases of strangulation in the alimentary tract, on the length of time and degree of destruction of tissue.

If the abdominal route is chosen the diaphragm will be found high, but if the opening were made through the chest in the same case, the diaphragm will be found low in the abdomen.

In a case in which Harrington operated closure was made remarkably easy by traction and destruction of the phrenic nerves entering the diaphragm. Contrary to what might be expected, the division of these nerves caused no trouble and the diaphragm was completely relaxed.

The mortality depends on many factors: the age of the patient, the type, situation and size of the opening, the degree of obstruction, and whether or not gangrene and perforation have already occurred. In the twenty-seven cases there were five deaths from operation; two of them a considerable time after operation, one nearly three weeks afterward from pulmonary embolism, and one nearly four weeks afterward, from peritonitis.

## CHRONIC SUBDURAL HÆMATOMA\*

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FROM THE NEURO-SURGICAL CLINIC OF DR. CHARLES H. FRAZIER, UNIVERSITY HOSPITAL

OUR knowledge of much of the pathology following cranial trauma is still very inexact. Many apparently severe injuries to the head will be recovered from completely, while a minor trauma, often ignored at the moment, may later be the cause of symptoms of amazing severity. It is to emphasize this fact and to stress the possible importance of even a trivial cranial trauma in unravelling obscure intracranial conditions that the following cases are reported.

CASE I.—L. B., aged fifty-two, a business man, was referred by Doctor Bastian, of Wilmington, Delaware. Four weeks previously he had fallen down a flight of stairs at night and fractured his collarbone. He was momentarily dazed, but never completely unconscious. There were no external lacerations about the scalp. The degree of head injury was so slight that it was soon forgotten, the broken clavicle being considered the important injury. He spent the next ten days about the house recovering from the general stiffness consequent to his fall. He then returned to his office and for a week carried on his business apparently in normal health. At this time he noticed a dull headache coming on particularly in the late afternoon at the close of the day's work. His business associates noticed a definite falling off in his mental acuteness, he became uncertain in the use of figures and exhibited irritability and lack of judgment. The headaches increased in severity during the next two weeks—he was often at a loss for the proper word, his speech became thick, and finally he had to abandon any attempt at working and take to his bed. We saw him at this time, six weeks after his injury, in conjunction with Dr. William G. Spiller, of Philadelphia.

Physical examination revealed a much disoriented, markedly word-deaf, and aphasic patient. He was semi-stuporous, but could easily be aroused when addressed. Retinoscopic examination showed a definite blurring of the margins of the optic discs of both eyes with tortuous and overfilled veins, but no measurable choking. The feeding test suggested a right lateral homonymous hemianopsia. The pupillary reactions were normal. There was a definite weakness of the right side of the face, especially about the angle of the mouth. The right extremities were somewhat weaker than the left, although he was right-handed. No sensory loss could be found. Slight but equal reduction of all reflexes was apparent. No Babinski, Clonus or Oppenheim were to be noted. The temperature was definitely subnormal but the pulse and respirations were not retarded. Albuminuria was reported. The blood-pressure was 130/80. X-ray of the skull demonstrated a long horizontal linear fracture in the left temporo-parieto-occipital region. A diagnosis of a left-sided ingravescient hemorrhage was made. Immediate operation was advised.

For various reasons operation was postponed for a week, fortunately without marked change in the patient's condition.

A large left temporo-parietal bone flap was turned down by Doctor Grant under general anæsthesia. The dura was tense, non-pulsating and a deep blue-green in color. On opening the dura a bloody serous fluid containing many small clots escaped with a sudden gush. A few small thin clots which could be easily removed remained adherent

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to the dura. In no area were the clots adherent to the arachnoid. The left cerebral hemisphere was compressed to such an extent that the olfactory nerve could be seen anteriorly, the lateral sinus posteriorly. The convolutions were flattened, the blood-vessels thin and compressed while the surface of the brain was of a yellowish-greenish tint. Careful examination failed to reveal any definite source for the hemorrhage. The dura did not appear to be thickened in any area, although its inner surface to which the more adherent of the remnants of the clot still clung was slightly roughened. As we wished to preserve the dura for a perfect closure, no part of it was excised. The bone flap was replaced without decompression. During closure of the wound it was noticed that the brain was already expanding and assuming a more normal appearance.

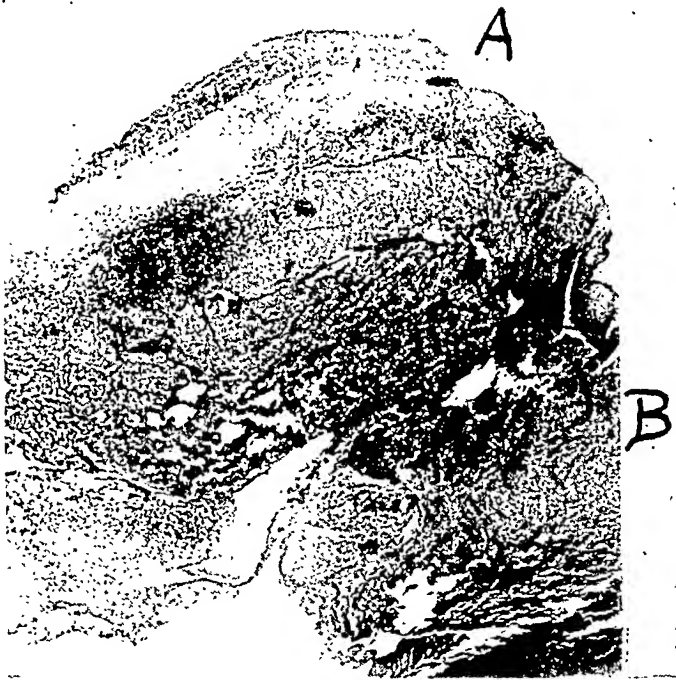


FIG. 1.—Case III. Low power of entire thickness through dura and underlying clot. The line of demarcation between clot and dura is easily seen. The area of subdural organization and irregular channels throughout the body of the clot are distinctly visible. A, dura; B, clot. H + E stain  $\times 10$ .

Convalescence was uneventful. The wound healed per primam. Within a week the patient was practically normal mentally, although his mind was a blank for events prior to a week before his admission to the hospital. Within three months he was again at his desk and has remained entirely well for over two years.

CASE II.—A married woman, C. McC., aged sixty-seven, was referred by Dr. William G. Spiller. Seven weeks ago while washing windows she fell four or five feet from a ladder to the pavement, striking her head in the left occipital region. A slight laceration resulted. As no one saw the accident, it is not

known whether she was ever totally unconscious, but she was able to pull herself together and walk into the house. She did not seem to be much injured and attended to her household duties the next day. From that time on she complained of severe occipital headache and dizziness, but she went about the streets alone and her condition was not considered serious. Ten days ago, one of her sons noticed that the right side of her face drooped. About this time she first noticed that she was deaf. Three days ago she vomited after eating, although this was attributed to her heavy meal. A day later, she was slightly stuporous, her speech was thick and monosyllabic. The next day she was profoundly stuporous, although she could be aroused to answer "yes" and "no".

Doctor Spiller saw her at this time. She was profoundly stuporous, could not be made to say a single word, and kept her eyes tight shut as though photophobic. She had a definite weakness of the right face and right upper and lower extremities. Sensation seemed normal throughout. The tendon reflexes in the upper limbs were normal. In the legs the patellar reflex was reduced on the right and hyperactive on the left; the Achilles normal and equal. There was a positive Babinski on the left. The blood-pressure was 120/70, the blood urea nitrogen normal, while the urine gave a trace of albumen. The eye and eyegrounds were normal. X-ray films of the head were negative. A lumbar puncture showed a clear fluid under 6 mm. Hg. pressure; Queckenstedt test showed a normal rise. Pulse and respirations were not retarded.



In view of the history of cranial trauma, Doctor Spiller made a diagnosis of intracranial hemorrhage. But because of her age and lack of evidence of intracranial pressure, we thought that she had a slowly developing apoplexy and advised further observation. The evening of her admission to the hospital, her pulse fell to 60 and we agreed with Doctor Spiller that an immediate operation was indicated.

Under light ether anæsthesia, reinforced by novocain, a left temporo-parieto-occipital flap was turned down by Doctor Grant. The dura was tense, non-pulsating and brownish-blue in color. On reflecting the dura a clot about 8 cm. in diameter and 2 cm. thick was exposed. It was slightly adherent to the dura by fine fibrous trabeculations, well circumscribed by a thin membrane, and not adherent to the arachnoid. It could be lifted in its entirety from the cortex. The centre of the clot contained cystic, bloody, grumous material. The cortex was flattened, anæmic and yellow in color. No evidence as to the source of the hemorrhage could be obtained.

The dura did not appear thickened, although its under surface was somewhat roughened and granular. None of it was removed for microscopic study. After complete hæmostasis the dura was closed, the bone flap replaced, and the scalp sutured as usual in layers. As the patient's blood-pressure was low, a blood transfusion was given. The wound healed by first intention. Except for a rather sharp attack of bronchitis, convalescence was uneventful. The patient was discharged three weeks later entirely restored to her normal mental and physical condition. She has remained well for three years.

CASE III.—F. B. F., a lawyer, forty-three years of age, was referred by Dr. Karl J. Kurz, of Mount Airy, Philadelphia, Pennsylvania. While bathing in the surf three weeks before admission he was knocked down and roughly handled by a number of heavy seas. On leaving the water he noticed a buzzing in both ears and was slightly dizzy. About an hour later, while dressing, a severe bitemporal headache developed. During the next hour, his vision became blurred and finally he developed complete blindness in his left eye with marked visual loss in the right. He consulted a local physician who put him to bed and purged him vigorously. The next morning he had recovered his sight completely, and the headache had somewhat abated. He stayed in bed that day, but twenty-four hours later he felt well enough to return home by train. A week after the onset of his trouble, he was back at work, although his head felt heavy and he was less alert mentally than usual.

Four days before admission he left home on an important business trip involving much mental strain. Forty-eight hours later, while examining a witness, he suddenly was at a loss for the proper word and within six hours became completely aphasic, answering only "yes" or "no". He was brought home at once, arriving in a semi-stuporous condition. Convulsions beginning in the right side of his face and involving his right arm next developed. Later he became deeply stuporous and untidy.

On admission physical examination revealed him in deep stupor with frequent convulsive twitchings of the entire right face and right arm, with occasional involvement of the left side of the forehead. The breathing was noisy and stertorous, the face somewhat livid. The pupils were normal in size, shape and reactions. The disc margins were blurred, the vessels overfull and tortuous, but there was no measurable choking. The lower jaw and tongue tended to deviate to the right and the right seventh showed definite weakness. All the extremities were spastic, especially the right arm and hand. The reflexes were all exaggerated especially in the right arm. There was a bilateral Babinski. No sensory loss could be demonstrated. All extremities were moved to pin prick equally well. Pulse and respirations slightly retarded. Temperature normal.

An abscess or a hemorrhage into a left temporo-parietal brain tumor was diagnosed. The trauma involved seemed of minor importance. At best, his condition seemed desperate.

At operation, since an abscess was suspected, a trephine opening under novocain

was made in the left temporo-parietal region by Doctor Grant. On inspection the dura seemed deeply bluish-green. The presence of a hemorrhage was then for the first time realized and with infiltration anæsthesia a left temporo-parietal bone flap was turned back. The dura was characteristic; tense, pulseless and greenish-blue. On incision a bloody grumous fluid escaped. At this point the patient had a violent right-sided convulsion and his respirations ceased. Under artificial respiration they commenced again and the dura was widely opened. This membrane was much thickened, especially over the underlying clot. This clot covered the entire hemisphere from the frontal to the occipital poles and extended over into the median fissure and beneath the brain in

the frontal, middle and posterior fossæ. It was rather firmly adherent to the dura from which it could be peeled, and, as it came away, fine fibrous trabeculations attaching it to the dura were noted. It was not at all attached to the arachnoid.

In its thickest part directly over the temporo-parietal region, the clot was four centimetres thick tapering off to one-half a centimetre in the frontal and occipital regions. All the accessible clot was removed by suction, but parts of it could not be reached at the base and in the median fis-

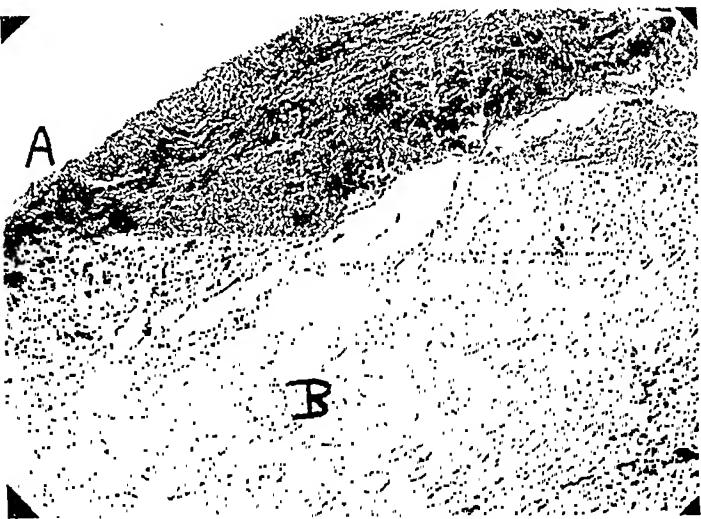


FIG. 2.—Case III. Low power of area of organization lying below dura. The line of demarcation and development of fibrous trabeculae and blood-vessels beneath dura are easily seen. A, dura; B, clot. H + E stain  $\times 80$ .

sure. The brain was so compressed that a large clotted mass was easily removed with gentle retraction of the frontal lobe from about the left optic nerve and chiasm. The cortex was flattened, anæmic, and pale yellow in color. A section of the thickened dura was removed for examination. Sufficient clot was withdrawn piecemeal to fill a six-ounce glass, besides that which disappeared into the suction tube. No definite bleeding point could be discovered, but the inner surface of the thickened dura was definitely roughened and oozed freely. The brain was rapidly regaining its normal contour, when, after a careful hæmostasis, the dura was closed. The bone flap was replaced and the galea and skin closed as usual in layers without drainage.

While the wound healed by first intention, convalescence was very stormy. He was extremely restless, disoriented and untidy for ten days. His speech returned slowly. A pleurisy and a cystitis complicated the recovery. However, five weeks after his operation he was sent home and there under familiar surroundings he rapidly regained his normal poise. He was forbidden to return to work for at least three months, but at the end of that period returned to his office. In spite of warnings he overtaxed his strength, and, following an alcoholic indiscretion, he had a right-sided Jacksonian attack in his face and arm with complete aphasia. He recovered in four hours, but was again hospitalized. As lumbar puncture and eye-ground examination revealed no pressure, he was discharged after a week. He then took a sea-voyage and rested for two months. During this time, following a fit of anger, he had one period of transient aphasia lasting an hour. He is to rest six months more at least before returning to work. He feels well, has gained weight, seems cheerful and is apparently his normal self, but he becomes excited rather easily. What the future will bring forth is uncertain, but it seems that the pressure to which his left cerebral hemisphere was subjected has rendered this region more irritable. Either that or the process in his dura is continuing and

pressing upon the left motor region. Possibly the entire thickened area of the dura, which would have included most of that membrane covering his left lateral hemisphere should have been removed at operation.

The exact pathology of chronic subdural hæmatoma is still obscure. Virchow,<sup>1</sup> in 1857, gave the first comprehensive description of the histology of the membrane. His explanation of its position, etiology, and formation has been freely accepted ever since.

He stated that the hemorrhage lies beneath the dura, outside the arachnoid, and not under the "parietal" arachnoid, a membrane which he showed did not exist. That a subdural hemorrhage might occur from trauma to cerebral vessels, or sudden rupture of a cortical vessel through the pia, or might even occur spontaneously in hemorrhagic, valvular or vascular disease was freely admitted. But from the histological formation of the structure he described and the clinical evidence of intermission and remission of symptoms, he did not believe that a single massive hemorrhage had taken place.

Virchow outlined the development of the condition as follows:

The dura becomes chronically inflamed as is evidenced by the exudation of a delicate layer of fibrin, at times blood-stained, over its inner surface. The widely scattered dural vessels send capillaries into this layer, proliferation of these capillaries follows, and, if the cause for inflammation is again active, another fibrinous layer may form and undergo organization.

As this process repeats itself a very vascular layer of new tissue is built up beneath the dura. These capillaries are extremely thin-walled and irregular, tending to rupture easily if congestion occurs. The subsequent hemorrhage may produce small ecchymotic areas which eventually absorb with the deposition of blood pigment; or a massive hemorrhage may occur from the involvement and rupture of many capillaries. The clot thus formed may in turn be similarly organized with further possibilities of hemorrhage as the vascularity increases. Virchow distinguished between the fibrinous exudation and its organization, which he termed *pachymeningitis interna chronica*, and the condition in which extravasation of blood was the most prominent feature—or *pachymeningitis hemorrhagica*. The blood-filled cysts he termed hæmatomas of the dura. The replacement of the hemorrhagic contents of these cysts by serum (hygroma of the dura) he recognized as a type of external hydrocephalus. Large extravasations he considered were always fatal, while small ones might regress.

However, Virchow was describing a condition he had seen in chronically diseased patients, particularly the insane, and not a consequence of traumatic hemorrhage. But there is no reason to believe that if a slow subdural extravasation of blood forming beneath the dura in a chronic wasting disease can be thus organized, that the hemorrhage following a slight trauma cannot undergo the same process and retain the same potentialities for secondary hemorrhage as vascularization of the clot occurs.

Hæmatoma of the dura resulting from trauma has received but scant attention in the literature. Putnam and Cushing<sup>2</sup> have prepared the most

important recent communication. They show excellently well by microphotographs the variations in structure between the subdural clot subsequent to trauma and that due to a chronic condition. The principal difference in these two types of clot is in their subdural structure. Against the arachnoid the enveloping surface is thin and covered with a layer of mesothelial cells in both instances. But in that area next the dura the clot formed following trauma "is more dense and composed of organizing granulation tissue containing large mesothelium-lined spaces containing blood and fibrin which appear to anastomose with each other and with the capillaries. In this

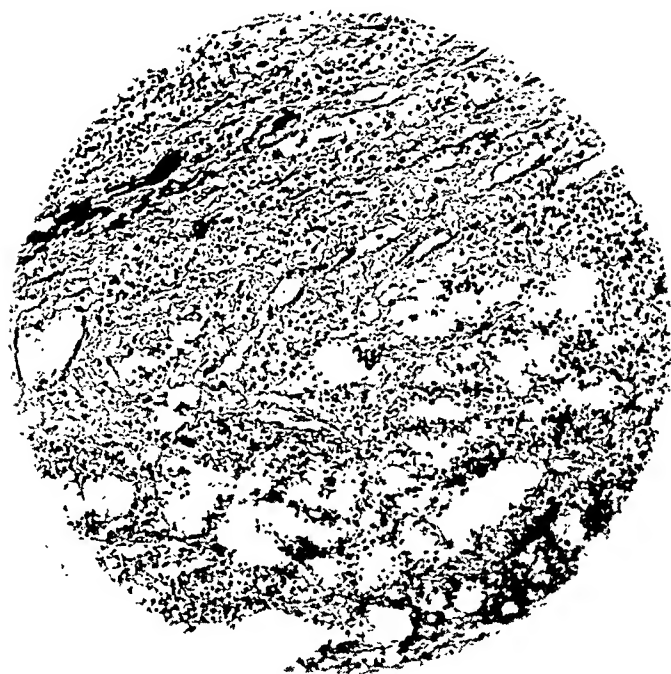


FIG. 3.—Case III. Section between well organized subdural area and less well organized clot. Nature of blood spaces in clot and their irregular size and shape may be noted. H + E stain  $\times 300$ .

respect the membrane of the traumatic hæmatoma seemingly differs from that of the commonly described pachymeningitis hemorrhagica interna, in which the thin-walled vessels are enormous and no mesothelium-lined spaces are seen. Such a pachymeningitic membrane may possibly give rise to hæmatomas, which symptomatically and in the gross resemble the post-traumatic variety."

But whatever the underlying pathology may be, whether the condition results from a

chronic inflammation of the dura in the course of a wasting disease or as a result of trauma, the clinical picture is exactly similar and the treatment is surgical intervention and evacuation of the clot. It is interesting to speculate as to the possibilities of an underlying weakness in the blood-vessel walls in these cases. The trauma which apparently initiates the condition may be so insignificant that it seems almost inconceivable that it could cause the rupture of a normal vessel. Chronic alcoholism seems to be a favoring factor in the production of this condition as pointed out by Kremiansky,<sup>3</sup> although Kasemeyer<sup>4</sup> and Bowen<sup>5</sup> attach little importance to it.

But even in the traumatic cases there must be very different types of reaction on the part of the dura to the underlying clot. In Cases I and II here reported, the dura did not appear grossly thickened, only slightly roughened here and there with small fragments of clot attached to it. All the rest of the hemorrhagic material gushed out suddenly and escaped as soon as the

dura was opened. In Case III alone was the dura greatly thickened. From a study of the accompanying plates it can be seen that the structure closely resembles that described as typical of traumatic hæmatoma. The clot is sharply marked off from the dura, well organized, and containing many fine blood-vessels in its subdural surface. The line of demarcation between dura and clot may be easily seen. Within the depths of the clot itself the vessels are extremely irregular in size and shape, are lined with mesothelial cells and contain red cells. Unfortunately a section cut from the material taken from the arachnoid surface of the clot has been mislaid so that the detail of this area cannot be shown.

The symptomatology of an ingravescent hemorrhage beneath the dura may be variable in the extreme. The long latent period is characteristic with usually a slow development of evidence of intracranial irritation and a rather abrupt onset of severe focal symptoms. Distinct remissions in the clinical course are frequent, as though a physiological reduction in the size of the brain occurred to compensate for the increasing size of the clot. Slowly signs of general intracranial tension appear, headache, vomiting and choked disc, while definite localizing signs come on at the last with startling abruptness and usher in a critical situation which may require immediate relief.

But when the very large size of the clot exposed is considered, it is remarkable how very few symptoms are present. Since curiously enough in all three of the patients here reported the lesion was over the left cerebral hemisphere, sensori-motor aphasia was an early finding. A certain mental blunting, irritation, and vague dispositional changes were recalled by near relatives on closer questioning as having been present for some time. After recovering, the patients themselves admitted that they had done things for which at the time they had no logical explanation, acting on a sudden impulse contrary to their customary habits.

The differential diagnosis usually lies between tumor, abscess, hemorrhage, or vascular disease, the degree of consideration given to hemorrhage depending upon the unearthing of a history of trauma. In these three cases the head-injury could be so clearly related to the onset of symptoms that the diagnosis should have been simple. Yet in Case II since no evidence of intracranial pressure existed, either from lumbar puncture or eye-ground examination, operation was at first delayed for an apoplexy was diagnosed. But the sudden drop in pulse showed that we were dealing with a condition requiring immediate relief. In Case III the degree of trauma was so slight that we suspected the presence of tumor or abscess and only when at operation the greenish-blue discoloration of the dura was seen was it realized exactly with what we were dealing.

Many confusing symptoms complicating the clinical picture have been described by various authors. As these three patients were all stuporous or semi-stuporous when first seen, our examinations were not as reliable or extensive as they might have been. The involvement of both sides of the face during the convulsions in Case III was the only confusing sign encoun-

tered. Albuminuria and an occasional rise in temperature were seen in Cases I and II. A slow pulse was not a constant finding. Only in Case I did the Röntgen-ray film show evidence of fracture. Retinoscopic examination showed evidence of pressure in two of these three patients.

The treatment of this condition consists in removal of the blood clot. This is best done by decompression or reflection of an osteoplastic flap. Occasionally, as in one of the cases reported by Putnam and Cushing, a simple trephine over the location of the lesion with the introduction of

a brain cannula may result in the evacuation of fluid content of the clot with apparently permanent relief of symptoms. Lumbar puncture has been reported as effecting a successful reduction of pressure in suspected instances of hemorrhage, although in these cases the actual presence of a clot was not confirmed. Certainly lumbar puncture is not to be preferred to direct drainage of the bloody fluid by insertion of a cannula through a trephine directly over it or to complete exposure and removal of the clot by a properly placed osteoplastic flap. Although we



FIG. 4.—Case III. Showing position of operative flap.

did not resort to it in the cases here reported, the making of a decompression at the base of the flap would seem to be a wise precaution to take care of the oedema of the brain and consequent rise in intracranial tension which may follow the sudden relief of pressure due to removal of the hemorrhage. It is this subsequent acute oedema of the brain which apparently was the cause of death in many of the fatal cases reported in the literature. This may in part be prevented by inserting drainage for a day or two. But if pressure signs develop it seems useless from the experience of other observers to re-elevate the bone-flap or to attempt to relieve the tension by lumbar puncture. Putnam suggests the use of hypertonic solutions by mouth and vein on purely theoretical grounds because other methods were unsuc-

## CHRONIC SUBDURAL HÆMATOMA

cessful. However, since the hemorrhage is frequently bilateral and since the undiscovered clot may be the cause of the continued pressure, he wisely advises that a small trephine opening be made routinely over the opposite cortex for inspection of the dura and the determination of the presence or absence of underlying blood. This should certainly be done if the patients do not rally well after the removal of the clot from one side. The first seventy-two hours post-operatively seems to be the critical period. If no complications appear during this time, the convalescence is usually uneventful. The end-results are on the whole very satisfactory, as most of the patients who survive the operation have had few of the usual sequelæ of cranial trauma.

### CONCLUSIONS

1. Ingravescient subdural hemorrhage may follow an apparently extremely insignificant cranial trauma. The underlying pathology and predisposing causes of the condition are not clearly understood, although it seems possible to differentiate microscopically between the subdural clot following trauma and that consequent upon chronic systemic disease.
2. Symptomatically the onset of intracranial pressure is insidious with a rather abrupt development of localizing signs pointing to involvement of a definite cortical area.
3. Exposure of the involved area by surgical means and evacuation of the clot is the proper treatment. Since such hemorrhage is frequently bilateral, inspection of the contra-lateral dura is always indicated.
4. If the post-operative course gives evidence of a return of intracranial pressure, this is due either to general cerebral œdema or an undiscovered contra-lateral clot. Lumbar puncture or re-elevation of the original flap does not seem to benefit the situation. Hypertonic solutions should be given a thorough trial.

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# ROOT SECTION UNDER LOCAL ANÆSTHESIA FOR THE RADICAL CURE OF TRIGEMINAL NEURALGIA MAJOR (TIC DOULOUREUX)\*

BY WILLIAM T. COUGHLIN, M.D.  
OF ST. LOUIS, MO.

TO BEGIN with, I am quite willing to grant that there are individuals who cannot be successfully operated on *at all*, even for most trivial or minor conditions under local anæsthesia; and furthermore, it is my very firm opinion

that there are some surgeons who will *never* excell in the performance of operations under local anæsthesia, nor even in its administration were it only for the most insignificant procedure.

There is, however, a large and increasing number of men, particularly young men, who have seen perfect local anæsthesia as it can be produced. It is not, however, particularly to these that I wish to address my remarks. It is rather to those who are still in doubt of its advantages that my experience with the method may be of some benefit.

Anyone who has successfully performed any operation under local anæsthesia with novocain, *i.e.*, who has carried it through from beginning to end and performed his operation with satisfaction to himself and without inflicting any pain or suffering on his patient, and has also performed the same operation under general anæsthesia, must have noticed several points of difference in the general and local operative and post-operative phenomena.

Among these, in operations on the brain and its membranes perhaps one of the most striking is the effect on the blood-pressure, or, if you will, let us call it shock. Now the advocate for general anæsthesia will quickly retort that "if the general anæsthetic is administered as it should be, it does not increase the shock." My reply to that is that it has been very conclusively proved that such a statement is not based on experimental research on the lower animals or on clinical observation, for it is well known that the

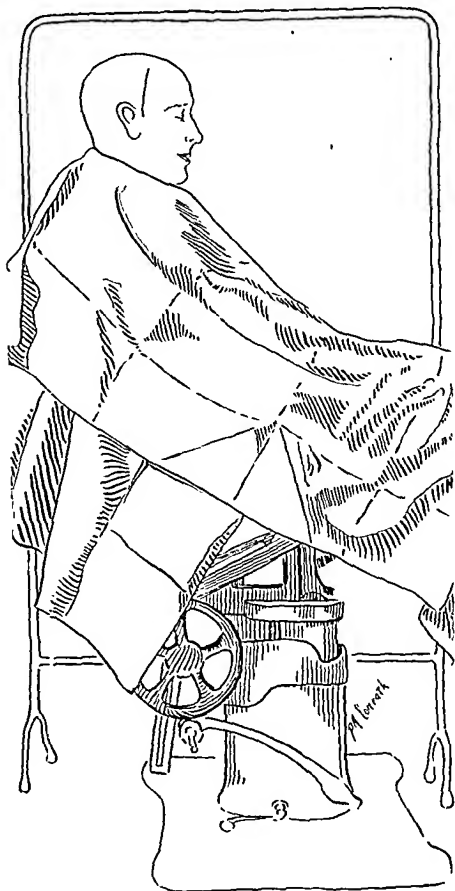


FIG. 1.—The patient is sitting up and will remain so, unless the blood pressure falls and the patient feels weak.

\* Read before the Southern Surgical Association, December, 1926.



## ROOT SECTION UNDER LOCAL ANÆSTHESIA

prolonged administration alone of ether, gas oxygen, or ethylene, does cause a fall in blood-pressure, and it has not been shown that the administration of novocain subcutaneously in such doses as required has produced any such result.

Another remarkable advantage that the novocain-adrenalin infiltration method possesses over general anæsthesia is the effect on hemorrhage. Every one knows how vascular the scalp is, and those who doubt the seriousness of blood loss from the scalp wound would do well to reflect that Cushing thought so seriously of it that he devised a tourniquet to aid him in its control. Others have spent time and ingenuity in constructing clamps, etc., for the same purpose. Many such devices are on the market. There can be no question of its seriousness. Crile has very clearly shown how blood loss increases shock, and any safeguard for prevention of blood loss is an added protection to the patient.

Three drops of adrenalin solution (1-1000), added to each ounce of the novocain solution, blanches the tissues to



FIG. 2.—A photograph of the patient draped ready for the operation.

such an extent that only the larger vessels bleed when cut or torn. The lack of oozing permits these to be quickly caught and tied. The novocain-adrenalin applied to the dura (as I apply it) does away entirely with the bleeding which accompanies the separation of the dura from the bone and allows a clear field, without the interminable sponging and the unavoidable and oft-repeated trauma and, above all, without accompanying blood loss.

Again the use of a local anæsthetic permits the operation to be performed with the patient in a sitting position. This in itself lessens the congestion in the scalp, skull, dura, and brain. We have been much influenced by this. It can be demonstrated by placing the patient in the horizontal or the half-sitting posture while the wound is still open but such an apparent truth should require no demonstrative proof.

The sitting position for this operation has its advantages other than the prevention of blood loss. The operator and his assistants operate without bending over the wound—a safeguard against infection. The level of the wound can be brought exactly into the horizontal plane, and in that our vision is more acute and more accurate than in any other.

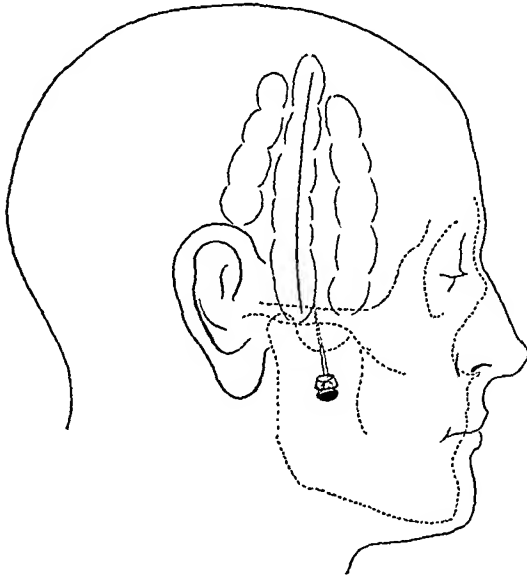


FIG. 3.—The tissues to the bone are infiltrated along the line of incision with 1 per cent. novocain in normal saline, freshly made, to which three drops of 1-1000 adrenalin have been added to each ounce. Now one inch away and on either side from the zygoma upward for a little over one inch, all the tissues are infiltrated with  $\frac{1}{2}$  per cent. novocain-adrenalin solution. With a needle four inches long I find the point of exit of the third division just as for alcohol injection and here I deposit 5 c.c. of the stronger solution.

his suffering, disappointment and pain, or he undergoes another operation,

Again, it has happened that a part of the nerve has been overlooked at operation under general anæsthesia. This is not nearly so likely to happen under local anæsthesia for once the cave of Meckel is opened pain can be excited by touching the crescentic edge of the ganglion with a probe as long as any sensory fibres remain uncut. We have never had to re-operate but once. In that case I wished to leave the upper third of the fibres, according to the method of Frazier, but I left more than I intended and the disease returned—and in the upper division as well.

The post-operative sequelæ are not more frequent under local anæsthesia, as far as I can learn, but I shall when the series is larger make certain on that point.

It is true that some, not many, operators perform this operation under ether with the patient in the upright (or nearly so) position. This operation, as is true of other operations within the cranium, may be prolonged, and those who have seen many know it can be bloody. I would not care to keep a patient under ether for a long period of time and maintain the upright position. It has happened that the operation had to be discontinued owing to the condition of the patient, and such a patient if he lives through the operation, after either continues to have his neuralgia which is not so good for surgery.

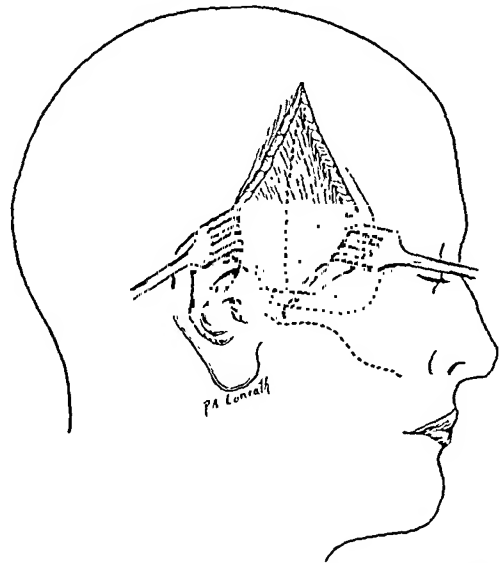


FIG. 4.—The dotted lines like an inverted "T" indicate the incision through the fascia temporalis. The crossed dotted lines show the position of the zygoma.

Patients who have high blood-pressure sometimes have this disease. I have had several plethoric persons with systolic blood-pressures ranging from 185 to 230. For such it is customary to advise deep injections of alcohol instead of the radical cure by root section. But in all this had already been done twice or oftener, in one four times, one of these had previously been refused operation. They have all been successfully operated upon under local anæsthesia.

Technic.—The head is shaved in all directions for about  $2\frac{1}{2}$  to 3 inches away from the site of the proposed incision. The patient is given a cathartic the morning of the day before and light diet given.

The patient's reaction to hyoscine morphine is determined prior to the day of operation, and if not tolerated, producing restlessness rather than drowsiness, no hyoscine is given. If, however, it is well tolerated,  $1/200$  grain hyoscine hydrobromide with  $1/8$  grain morphine hydrobromide are given subcutaneously one hour before operation.

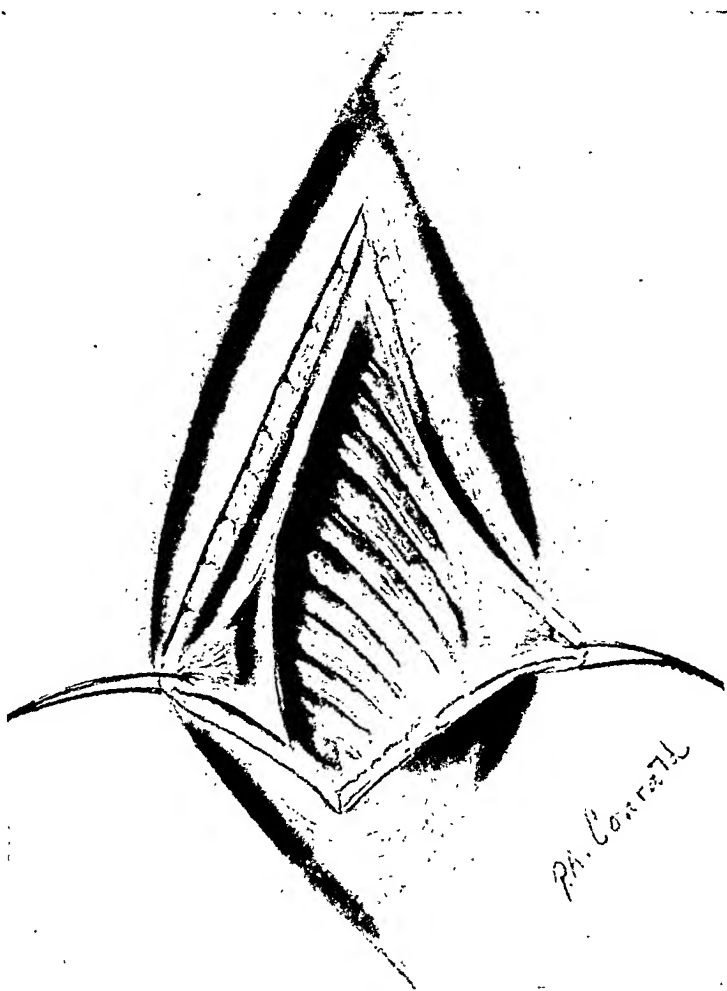


FIG. 5.—The scalp and temporal fascia are drawn well out of the way by stout silk threads. The lower border of the temporal muscle is then found and the lower fibres freed from their origin and drawn well forward and upward.

Sometimes these patients have acquired a tolerance for morphine, and in these the tolerance is ascertained and such a dose given as will just produce drowsiness. The combination so used has never yet caused me any regrets, but I have had serious consequences in a minor operation with  $1/4$  grain morphine and  $1/150$  scopolamine. I always try it out first.

The patient sits up either in a dental chair or on a table that can be put in a chair position. Such chair or table can be quickly let down to the horizontal or even Trendelenburg position if necessary. Some patients faint or change their minds with regard to the anæsthetic before (or even after) the operation has begun. I never insist on continuing under local anæsthetic over the protest of the patient.

After the field is prepared, iodine-alcohol method, the towels and sheets

are draped over the head and down over the body and chair to the floor on the side to be operated upon; a slit in the centre of the sheet lies over the line of incision; the sheet is carried up from the field over the head and then away from the patient on the opposite side like a sort of tent-flap. This allows free access of air to the patient and excludes the nurse and the physician (regular anaesthetist) who are always present to watch the condition of the patient and

to be available should they be needed.

The line of the incision is indicated by scratching the skin. I now use a vertical incision, or sometimes one inclined slightly forward and upward, having found it preferable to that described in my first communication. It reaches from the zygoma upward or upward and a little forward for  $2\frac{1}{2}$  to 3 inches, and the lower end is about a finger-breadth in front of the ear.

The tissues to the bone are now infiltrated along the line of the incision. I use 1 per cent. novocain in normal saline, freshly made, and each ounce contains 3 drops of 1-1000 adrenalin. In front of this and one inch

away on either side I inject from the zygoma upward for a little over one inch infiltrating as before all the tissues. For this I use only 0.5 novocain-adrenalin. It is well to get as much of the solution as possible under the periosteum over the area of bone to be removed. This is done before making the incision and preferably with the strong solution. It can be easily done if the needle is inserted from above downward in the planes of the surfaces of the temporal and the zygomatic fossæ. With a needle four inches long, I find the point of exit of the third division just as for alcohol injection, and here I deposit 5 c.c. of the stronger solution.

The incision is now made, and any bleeders caught and tied. The fascia temporalis is cut in the line of the skin incision, and in addition it is freed

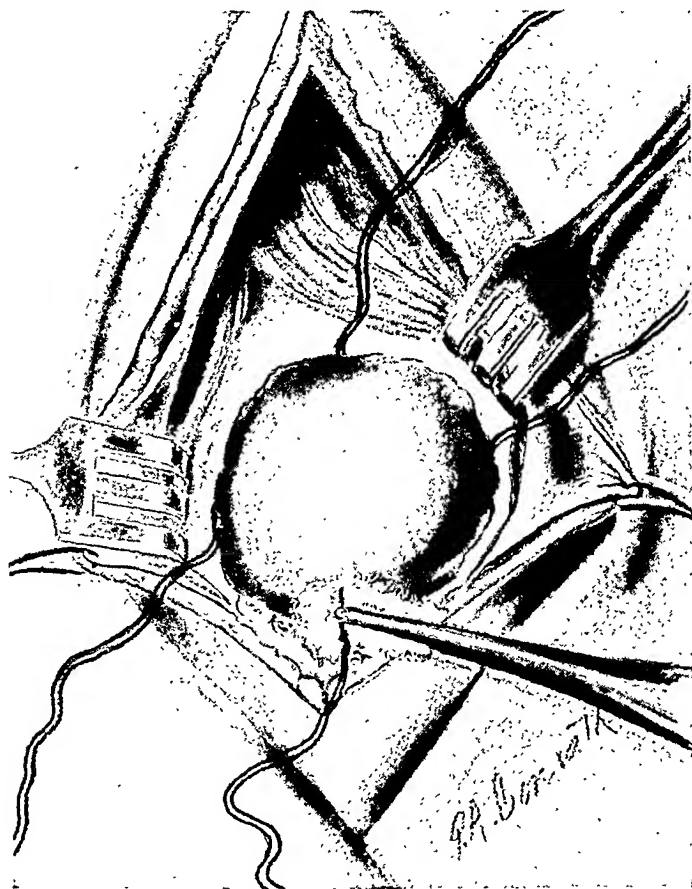


FIG. 6.—The opening in the skull is low down and about the size of a half dollar. Pledgets of cotton to which threads are attached are used for separating the dura from the bone. When the bleeding is severe in one spot, the pledget is left in and the operator works elsewhere for a while. The pledgets are soaked in  $\frac{1}{2}$  per cent. novocain, to which the drops of adrenalin have been added to every ounce.

from its attachment to the zygoma. This last is done with a scissors, after having carefully lifted up the overlying skin and fat and up-going branches of the seventh cranial nerve to the frontalis muscle. These branches might easily be cut while one is cutting the temporal fascia free from zygoma, for they lie very close to the outer surface. To cut it forward  $1\frac{1}{2}$  inches is enough and backward - about  $\frac{1}{2}$  inch. I have never done the operation without the transverse cut in the fascia. The proper exposure cannot be obtained.

The edges are now retracted and the lower margin of the temporal muscle found. The lower fibres for  $1\frac{1}{2}$  inches are cut away from their origin and the periosteum and overlying muscle are loosened and carried forward together. Good retraction is made, so as to expose the lower part of the squama and the wing of the sphenoid above the zygoma. A hole is now drilled and enlarged with a rongeur. The bone is removed well downward quite to the base. The area of the opening need never be more than that of a half dollar (about 3 cm.).

Now begins the task of separation of the dura. This is never done with an "elevator" of any kind.

The dura is often so thin in places that only the inner layer is present and this tears very easily. The suggestion of Tiffany long ago "to separate the dura from the bone with a pledget of cotton grasped in a bullet forceps" I have acted upon. We use cotton pledgets of two sizes, large—about as thick as the thumb and about one inch long, and small about the thickness of the



FIG. 7.—A self-retaining retractor is used for the muscle and overlying structures. A lamp retractor lifts up the dura and brain. The middle meningeal artery has been tied. Most frequently we plug the foramen spinosum with a little wooden peg. The dura covering the third division has been incised, the incision extending backward and upward, and the dura has been reflected from the outer aspect of the ganglion, the sensory root has been cut, the motor root is visible in the background. Running from behind forward and inward and disappearing behind the ganglion can be seen the great superficial petrosal nerve.

little finger and also about one inch long. Each pledget is tied around with a strong black-linen thread, the two ends of which are left long, at least seven inches. These threads hang out through the opening in the skull, as the pledgets are left *in situ* to control oozing, and having the threads long and black prevents the leaving of one within the cranium. The cotton pledgets are wet with the 0.5 per cent. novocain-adrenalin solution and grasped in an ordinary, rather long, dissecting forceps. If the patient complains, the pledget, very wet, is gently placed at that point and allowed to remain and another

### Anesthetic Chart

Age 61 Sex M

Anesthetic Began 9:20 a.m. Ceased 11:20 a.m.

Anesthetic Procuraine - Curaridin Narcotic Morphine Hyposens 200

Simulation

B. P.	P.	Res.	1ST HOUR	2ND HOUR	3RD HOUR
230	210	95			
220	210	95			
210	210	95			
200	200	85			
190	190	75			
180	180	65			
170	170	45			
160	160	40			
150	150	35			
140	140	30			
130	130	25			
120	120	20			
110	110	15			
100	100	10			
90	90	5			
80	80	5			
70	70	5			
60	60	5			
50	50	5			
40	40	5			
30	30	5			
20	20	5			
10	10	5			
0	0	5			

CODE—O—Resp. V—S. P. X—Pulse

Postoperative Condition Good

Remarks

Anesthetist McKernan

FIG. 8.—Blood pressure chart. This chart is on the back of the ordinary operation sheet.

point is attacked. This is kept up until the dura is entirely separated as far as the foramen spinosum. If a point is reached where there is much oozing or real bleeding one of the larger pledgets packed between dura and bone controls it and the operator turns his attention to some other point for a few minutes. One is surprised at first on removing such tampon to find a dry field, but he soon learns that is a usual happening. Often I have as many as four or five tampons within the cranium at the same time. If in spite of all care the dura is torn, I do my utmost to repair it at once using mattress silk sutures.

When the foramen spinosum is reached the middle meningeal artery is found. At first we often had to stop and use much of the 1 per cent. novocain on pledgets here, and also when we had reached the foramen ovale. Since we began to use the deep injection of novocain outside the skull at the exit of the third division, I have not noticed any protest on the part of the patient while dealing with the artery.

Sometimes one can use a blunt feeler and discover the direction of the canal through which the artery enters the skull. If this is once learned it is very simple to make a little peg (I use a bit of an applicator). These pegs are pointed a little at one end and are never more than about one-third to

When the foramen

When the foramen is found At first we often gain on pledgets here, and since we began to use the exit of the third division, I impatient while dealing with cover the direction of the if this is once learned it is

## ROOT SECTION UNDER LOCAL ANÆSTHESIA

one-fourth of an inch long. One can press such a peg into the hole alongside the artery and leave it there and then cut the vessel. In my early cases I ligated it with silk. I have had to ligate the distal end once.

The dura is firmly fixed to the third division, where it leaves the skull, and is incised before it can be raised from this division and the ganglion. If this is painful, I inject some of the 1 per cent. novocain right into the third division where it leaves the ganglion. After a few minutes the dura can be pushed up and the ganglion exposed. One works backward and inward and a little upward, and presently the inner layer of dura is seen stretching from the outer layer (outer wall of cave of Meckel) onto the ganglion itself. This inner layer is now cut and the cerebrospinal fluid begins to flow. If, before this, one has secured a good separation of dura as far as the apex of the petrous, by hooking the beak of the retractor (author's pattern) into the opening of the cave, he can now have a good exposure of the sensory filaments as they join the posterior crescentic margin of the ganglion.

Even though one may be able to painlessly separate the dura from the ganglion, yet I find that very often just touching the sensory fibres excites pain. To anæsthetize them I take a very small, soft pledget of cotton and, after soaking it well in 10 per cent. novocain, lay it in the cave on the root and remove the retractor. After three minutes the fibres are cut a few at a time, using a long-handled, small, sharp knife.

The sensory fibres undulate in the waves of cerebrospinal fluid as this respond to respiration or heartbeat, that, their size (smaller than the motor root), their attachment to the ganglion, and their different shape (they are round, the motor root is flattened) as well as the fact that the motor root is likely to be a shade whiter in color, all enable one to distinguish them from the motor root.

After cutting the sensory fibres, all cotton pledgets are removed from the wound. If there is any bleeding-point, a bit of muscle is laid on it, and a larger bit is laid in the cave to stop the cerebrospinal fluid from flowing. The wound is closed without drainage and a generous dressing applied.

A goggle with close-fitting rubber rim is applied for a few days, or, if none is at hand, the lids are kept closed with collodion or adhesive or both.

# THE IMPORTANCE OF RÖNTGEN EXAMINATIONS IN THE DIAGNOSIS OF FRACTURES OF THE SKULL

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AND

PER HOLMSTRÖM, M.D.

OF STOCKHOLM, SWEDEN

FROM THE SURGICAL CLINIC OF THE SERAFIMERLASARETT, STOCKHOLM (DR. TROELL)

IT IS quite true, of course, that the serious prognosis associated with fractures of the base of the skull is not so much to be ascribed to the fracture itself as to the lesion of the brain; the disastrous effect is the result of a sudden, marked increase of the intra-cranial pressure, largely caused by the hemorrhage accompanying the fracture. Nevertheless, clinical experience shows that even injuries to the head, not clinically diagnosed as fractures, but only looked upon, for example, as a contusion of the head complicated by cerebral concussion (*commotio cerebri*), may give rise to very prolonged and troublesome sequels. This is particularly the case where the surgeon in attendance, in considering the injury to be of relatively mild nature, permits an early discharge of the patient and allows him soon to resume his usual work. This is emphatically brought out by the social accident insurance—as an illustration it may be mentioned *that out of 152 cases of cerebral concussion, compensated by the Swedish State Insurance during 1918–1920, no less than 9, or nearly 6 per cent., have had to be granted for at least some year rent.* In writing out certificates it is a poor consolation—and in many cases surely quite unfounded—trying to convince the patient and oneself that it has “merely” been a question of a traumatic neurosis in consequence of many a time a brief and, as it seemed at first, rather an unimportant injury. It is our definite impression that many, perhaps most, of these for a long time persistent and symptomatically very varying post-traumatic troubles are due to the fact that the injury from the outset has been anatomically of much more serious nature than the usual clinical examination has given reason to believe. In recent years we have had the opportunity at the Serafimerlasarett—thanks to the great courtesy and help from the röntgenologists (Professor Forssell and his assistants) to verify this supposition by supplementing the clinical findings with Röntgen photographs. For it has been shown by these that even in cases where otherwise evident symptoms have given no reason at all for suspecting fracture of the skull, such lesions nevertheless occur in head injuries much more often than can be established by purely clinical methods. Röntgenology, therefore, has also here, as in fractures on the whole, proved its great importance as an aid to diagnosis.

The following account is a tabularized summary of serious head injuries (except gun-shot and kindred injuries) for the period April 1, 1922, to December 1, 1926, admitted to that part of the surgical department at the



## RÖNTGEN DIAGNOSIS OF SKULL FRACTURES

Serafimerlasarett, which, as long as it was divided into two clinics, constituted Clinic I. All head injuries, clinically diagnosed as fractured base, contusion and compression without concussion of the brain, have been included, and in addition those cases of head contusion with or without scalp wounds which, although without definite cerebral symptoms, yet were of such nature as to call for Röntgen examination; finally, for the sake of completeness we have also included cases of *fractura thecæ cranii* from blunt injury (all other fractures concern the base of the skull).

Below will be submitted, for the sake of clearness a tabulated summary of the results obtained after inquiring into the clinical reports in regard to the question *how often Röntgen has been positive and negative in the diagnoses set out below, based upon ordinary clinical examinations.*

	Purely clinical diagnosis	Fracture detected by Röntgen	No or uncertain fracture according to röntgen	Röntgen not done
1. Severe head contusion with or without scalp wound	14 cases	5 cases	9 cases	
2. Cerebral concussion . . . . .	118 cases	11 cases <sup>1</sup>	45 cases <sup>2</sup>	62 cases
3. Cerebral compression . . . . .	23 cases	17 cases <sup>3</sup>	4 cases <sup>4</sup>	2 cases
4. Cerebral contusion . . . . .	7 cases	1 case	4 cases	2 cases <sup>5</sup>
5. Fracture base of skull . . . . .	7 cases <sup>6</sup>	6 cases	1 case <sup>7</sup>	.....
6. Fractura thecæ cranii . . . . .	6 cases	6 cases	.....	.....
	.....	46 cases	63 cases	66 cases

Total, 175 cases of which 109 have been röntgenologically examined.

1. Five of these cases were bleeding from ear or nose. 2. Three of these were bleeding from the ear. 3. Eleven of these were bleeding from the ear, etc. 4. Two of these were bleeding from the ear, etc. 5. Both dead and examined post-mortem: fracture present. 6. In all these seven cases there was bleeding from the ear in addition to paralysis of N. VII or, in one case, N. VI. 7. Clinically this case was an undoubted fracture.

In *Bloch's* \* excellent account three factors are given as absolute evidence in favor of fractures of the base: 1. Fall from some height or similarly obtained head injury. 2. Bleeding from the ear (or possibly nose or mouth). 3. Facial paralysis. As other valuable symptoms are given: 4. The finding of brain substance in ear or nose. 5. Cerebrospinal fluid from ear (or nose). 6. Secondary hemorrhage in the cutis of the eyelids or in the subconjunctiva.

*Quervain* † gives the following symptoms in support of the diagnosis of subcutaneous fracture of the skull: 1. Direct and indirect pain on pressure. 2. Displacement and abnormal mobility. 3. Hemorrhage (of very great diagnostic importance; frequently the only symptom) from ear, mouth, nose, or subcutaneously. 4. Escape of cerebrospinal fluid. 5. Alteration of percussion. 6. Röntgen. "Lassen sich auch die Schädelbrüche meist ohne dasselbe erkennen, und fehlen auch in vielen Fällen von klinisch festgestellter Fraktur Veränderungen im Radiogramme, so bringt uns dasselbe doch in anderen Fällen eine willkommene Bestätigung der Diagnose und zeigt uns sehr genau Form und Verlauf der Bruchlinien" (page 6).

\* Chirurgen i Klin. forelaesninger: Bd. Ia, p. 62.

† Chir. Diagnostik: 1919, p. 1. Most authors of text-books say nothing about Röntgen.

In the light of these statements appearing in text-books—and in view of the general impression probably formed, on the whole, by hospital surgeons regarding the frequency of fractures of the skull—our figures from the Serafimerlasarett would seem to deserve due consideration. Röntgen has unfortunately not been employed in as many cases as might have been wished.‡ In the first year (1922) it is lacking in no less than 85 per cent. in cases of cerebral concussion; in the subsequent years in about 50 per cent. The investigations have made it quite clear, however, *that fracture of the base of the skull is of far more frequent occurrence than can be established by purely clinical examination. Out of all cases röntgenologically examined, 109 in all, fracture of the base could clinically, without Röntgen, be considered definitely certain in only 7 cases (injury to head plus bleeding from ear plus paralysis of N. VII or VI; in only one of these cases was Röntgen negative). In 21 cases of cerebral compression, clinically diagnosed, there were no less than 17 with a fracture visible under the Röntgen-rays (11 of these had in addition to compression symptoms bleeding from the ear, nose or mouth). In 56 cases with a clinical picture of cerebral concussion there were 11 fractures (5 of them had bleeding from the ear, etc.). And of 14 injuries to the head which showed no signs of intracranial complications, there were 5 fractures. In the material under review, therefore, Röntgen has shown itself an exceedingly valuable aid to diagnosis; thanks to this fracture of the base was detected in no less than 17 of 21 cases (ratio 1: 1.2), clinically diagnosed as cerebral compression, and in 11 out of 56 (ratio 1: 5), clinically diagnosed as cerebral concussion.*

It stands to reason that at least some of the more or less persistent symptoms occurring after severe head injuries are due to some organic injury—fracture—of a kind not definitely demonstrable by ordinary clinical examinations; and so, even should the diseased condition itself have had a relatively short duration. It is therefore of considerable importance, not least in regard to the generous compensation liabilities guaranteed by the state social accident insurance in injuries through accidents during work, to supplement the examination of head injuries by Röntgen, even should the symptoms otherwise indicate no more than a cerebral concussion or compression, and even should in severe trauma symptoms of some of these intracranial complications be missing.

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‡ The chief reason for not examining a case under Röntgen has had nothing to do with it being considered particularly mild. It has been more connected with the necessity—from want of accommodation—to discharge the patient as soon as possible for further treatment at home or elsewhere.

# EXPERIMENTAL SURGERY OF THE ŒSOPHAGUS\*†

SOME FACTORS AND END RESULTS

By GEORGE L. CARRINGTON, M.D.

OF DURHAM, N. C.

THE present status of œsophageal surgery is ample evidence of the difficulties that it presents. While the cervical œsophagus is relatively accessible, the thoracic viscus is one of the most inaccessible organs of the body. It lies in the cavity that contains the chief elements of the circulatory and respiratory apparatus and is in close proximity to the great vessels and important nerves. It is short and by reason of its attachment to the pharynx above and to the diaphragm below it is subjected to a pull with each act of deglutition and with each respiration. The resection and suture of a viscus with such attachments is a very different matter from that of a loose lying coil of intestine. Not only does it differ in the matter of tension, but the intestine is covered by a serous coat that is resistant to infection and that quickly throws out a plastic exudate to seal a suture line. Again, the lumen of the normally healthy stomach and small intestine is relatively free from pathogenic bacteria, while the lumen of the œsophagus may contain practically any of the organisms found in the mouth. The ease of the development of a mediastinitis or a pleuritis, and the severity of such infections when they have occurred, would render this field different from others even if surgery here were not handicapped by the immediate operative problem of sustaining life by artificially maintaining respiration during manipulations. In addition to these things, the blood supply of the œsophagus when compared to that of the intestine is poor—and the circulatory factor is always one of the chief elements in healing.

Until Sauerbruch devised his differential pressure apparatus some twenty-two years ago, little clinical or experimental work had been done in the chest, beyond the drainage of fluid or pus from the thoracic cavity. When this method had been simplified by the development of the Meltzer-Auer and other apparatus for positive pressure intratracheal insufflation, thoracic surgery had then had its foundation prepared and its cornerstone laid. Before that time it is true that an occasional surgeon would attack the œsophagus in case of injury, endeavoring to operate without opening the pleural cavity. The Russian, Nasiloff, first worked out an approach through the posterior mediastinum. Since then a number of surgeons have used this method of attack, each more or less modifying it to suit his special needs. Lilienthal's<sup>1</sup>

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\* The work upon which this paper is based was done in the Brady Laboratory of the Yale Medical School and in the Laboratory of Experimental Surgery of The Medical School of the University of Pennsylvania.

† Read before the Philadelphia Academy of Surgery, May 2, 1927.

partial success by this route is probably the best known example. But the extreme difficulty of avoiding a tear in the pleura and the difficulty of "cruising" sufficiently to handle the pathology adequately will no doubt prevent its great development. This last difficulty was probably responsible for Lilienthal's failure to obtain a lasting success.

A number of approaches have been tried for œsophageal work. In the neck an incision along the anterior border of the sterno-cleido-mastoid muscle gives a fairly satisfactory approach from either side. In the chest the long intercostal incision popularized by Torek, with the addition of adjacent rib-cutting near the spine when necessary has been the one most frequently employed. A number of surgeons, however, prefer the posterior mediastinal route as we have said; while a few, of whom Von Mikulicz<sup>2</sup> was first, have tried an anterior approach, dividing or removing the sternum. Kummel, Rehn, Levy and Lilienthal all seem to favor an extra-pleural operation. In dogs a long intercostal incision has been employed for the most part—usually in the eighth interspace. The incision may be made on either side. I have usually gone in on the right side because it gives a good exposure without the heart's interfering with the operator, and I think, without the operator's interfering with the heart quite so much.

Biondi as early as 1896 had opened the left pleura, incised the diaphragm, pulled a part of the stomach into the thorax, resected a portion of the œsophagus, closed the lower stump and anastomosed the upper segment to the stomach. Dobromyslow,<sup>1</sup> working in Tomsk in 1901, performed a successful intra-thoracic suture of the œsophagus. He used two rows of silk sutures. Mikulicz in 1904 resected four centimetres of the lower end of the œsophagus, made an end-to-end anastomosis, mobilized the œsophagus, transposed the suture line to the abdomen through the hiatus in the diaphragm, and sutured the diaphragm to the œsophagus above the anastomosis. The dog lived six weeks. In 1913 Omi,<sup>4</sup> in South Manchuria, reported seven out of nine successful anastomoses of the cervical œsophagus; and of five intra-thoracic œsophago-gastrostomies three showed intact suture lines, though two of these died. He used silk sutures in three layers—the first through the mucosa, the second through the muscle and adventitia and the third through the muscle. He thought the anastomosis sufficiently reliable for use in man, if dog work is applicable to the human. Laird F. Kroh, Henry P. Brown, and Harry Bailey working in the University of Pennsylvania Laboratory reported in a paper read before the Deaver Society in 1913, but not published, the successful performance of six out of six end-to-end anastomoses of the cervical œsophagus. They had first performed four unsuccessful operations, using two layers of continuous sutures. In the six successful operations that they performed they used three layers of interrupted sutures. The first layer included the mucosa only, the second layer took in muscle and adventitia, and the third consisted of a row of stay sutures to take the tension off the other layers. They also made the observation that the stricture at the site of operation decreased as time went on. The dogs were sacrificed at intervals of 59 to 120 days.

Sauerbruch<sup>5</sup> after a long and discouraging effort to perform a successful end-to-end anastomosis decided that it was impossible to do so by suture, but he did succeed ten times out of thirteen in anastomosing the œsophagus to the stomach by means of a Murphy button. He laid great stress upon the necessity of preserving the most careful asepsis in the thoracic cavity.

Miller and Andrus<sup>6</sup> operated upon eighteen dogs, using a modification of Doctor

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Halsted's<sup>7</sup> bulkhead operation in order to preserve asepsis in the chest. They anastomosed the oesophagus to the stomach. Of these animals, fourteen survived operation, and eleven of the survivors had intact suture lines. Of these eleven, however, two died of dilatation of the stomach after 21 and 24 days, four of distemper 3, 7, 17 and 20 days after operation, and one of diaphragmatic hernia on the sixth day. Three others died of infection. Of the ten dying, however, all had intact anastomoses.

The effort to relieve tension from the suture line and to replace oesophageal defects have taken many forms. It is sufficiently difficult to make a



1 (Thorax 126 days)

2 (Thorax 37 days)

3 (167 days)

FIG. 1.—All specimens except No. 12 show the oesophagus distended with preserving fluid. No. 12 shows the specimen cut open and presenting the mucosal surface at the site of the anastomosis. Some of the silk sutures are visible. It will be noted that in this seven-day specimen epithelization is almost complete. Specimens Nos. 4 and 10 show the exterior of the oesophagus. Specimens Nos. 1, 2, 3, 5, 6, 7, 8, 9 and 11 are all turned inside out and distended with preserving fluid. These specimens thus show the actual size of the lumen at the site of anastomosis as compared with the size of the remainder of the oesophagus. They show the condition of the mucosa and the marginal ulcers with projecting suture material. Specimens Nos. 1, 2 and 9 are from the thoracic portion of the oesophagus. The others are from the cervical portion.

permanently successful anastomosis after simple division of the viscus, but when a considerable portion of the organ is removed—as must be done clinically for carcinoma—then for an anastomosis to be successful some plastic or substitutive procedure must be employed. These have been numerous; and their very number means that perfection is still far off.

Dr. Duff S. Allen<sup>8</sup> recently tabulated these procedures as follows:

1. Cervical oesophagoplasty by means of skinplasty.
2. Extrathoracic oesophagoplasty by means of skinplasty of neck and anterior thorax.
3. Inferior extrathoracic oesophagoplasty by use of a portion of the jejunum.
4. Inferior extrathoracic oesophagoplasty by use of a portion of the jejunum and skinplasty.

5. Inferior extrathoracic œsophagoplasty by use of a portion of the transverse colon.

6. Inferior intrathoracic œsophagoplasty by use of the stomach.

7. Inferior extrathoracic œsophagoplasty by use of a tube of the anterior wall of the stomach.

8. Inferior extrathoracic œsophagoplasty by use of a tube of the greater curvature of the stomach.

9. Inferior extrathoracic œsophagoplasty by use of the first horizontal portion of the duodenum.

10. Posterior thoracic œsophagoplasty by the use of skin flaps. Reconstruction of half of the circumference of the œsophagus with fascia has been done by Razzaboni and Neuhof.

1. Cervical œsophagoplasty by use of the sheath of the rectus and peritoneum.

2. Cervical œsophagoplasty by use of the fascia lata.

Torek<sup>9</sup> has been firmly of the opinion that for carcinoma the whole œsophagus should be removed. His successful case had this procedure, as did also the later case reported by Eggers.<sup>10</sup> In both of these a gastrostomy was done, the tumor-bearing portion of the thoracic œsophagus resected, the cardiac stump inverted and the oral stump brought out through the neck on the chest. Many of the methods devised by experimenters in their efforts to remove the œsophagus aseptically have been ingenious. Levy<sup>11</sup> did a gastrostomy, passed a tube with a thread down the œsophagus, divided the viscus in the cervical region and then by means of the thread invaginated the lower portion into the stomach. Kelling, 1902, did very much the same kind of thing but pulled the œsophagus out through the neck instead. He made an incision in the chest and freed the œsophagus, did a gastrostomy and resection of the lower œsophagus from the abdominal side, plugged up the lower end of the viscus and then pulled it out through the neck incision. Ash, 1912, did much the same thing, but used only two incisions—one in the neck and one in the abdomen.

The question of drainage has given rise to a variance of opinion. Airtight drainage has been demanded by some surgeons (Kuttner, Meyer, Tiegel, and Mikulicz) while some, among whom is Sauerbruch, close tight without drainage. Of course, after resecting any dirty viscus with chances for infection rather high, most surgeons want to drain. But the difficulty of maintaining drainage and lung expansion, too, is practically insurmountable in dogs and in humans requires special equipment. Keeping the lungs expanded is of the first importance, for the pleura appears to be much more subjected to infection in the presence of a pneumothorax than when the lungs are fully expanded. In dogs the lungs should be distended to fill the chest cavity before the thoracic wall is closed.

Our initial attempts at suturing the œsophagus were made in the cervical region. An incision was made along the anterior border of the sterno-cleido-mastoid muscle, the carotid vessels and vagus were pushed medial-wards and the œsophagus lifted out of its bed. In one dog a longitudinal incision was made in the viscus. This was closed with two layers of interrupted sutures and healed nicely. Then in another dog a longitudinal and a transverse incision were made. These were closed as in the first dog with two rows of interrupted Lembert sutures, and these healed nicely. The second dog upon which we attempted a complete transverse section of the œsophagus survived for 37 days before he was killed in a dog fight. In

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that dog, the oesophagus after being delivered was clamped with two Kocher clamps, a row of interrupted silk Lembert sutures was placed all the way around the oesophagus, which was then cut between the clamps. The sutures were drawn tight and the clamps carefully released and withdrawn. The sutures were again drawn tight as the clamps were removed, and this time were tied. Another similar layer of interrupted silk Lembert sutures were placed outside the first row. Each suture included muscle and adventitia. The neck wound was closed tight and the dog made an uneventful recovery.



4 (91 days)

5 (406 days)

6 (441 days)

FIG. 2.—See legend under Fig. 1.

It was the only successful case obtained by that technic. The other dogs developed either a fatal mediastinitis or more frequently a sloughing oesophagus that failed to hold.

Later we modified this method of anastomosis and included tension sutures as a result of the work of Doctors Kroh, Brown, and Bailey, which was called to our attention through the kindness and interest of Dr. J. E. Sweet. All the anastomoses reported in this series were performed essentially according to the following technic:

After delivery of the oesophagus the surrounding tissues were packed off by warm moist gauze. The oesophagus was encircled by two narrow tapes placed about two inches apart. These tapes were drawn tight enough to prevent noticeable leakage through the lumen, but not tight enough to damage the muscular coat. In the portion of the oesophagus between these tapes a small incision was next made, or a Luer needle was inserted into the lumen, and either through the incision or the needle a solution of some anti-

septic was injected—mercurochrome 220, a weak iodine or a chlorine solution. After the lapse of what was thought to be sufficient time for the sterilization of the lumen the œsophagus was divided in this supposedly sterile area. Three points on each cut end of the œsophagus were caught up each equidistant from the two other points on the same end, and joined by an interrupted suture to the corresponding points on the opposing cut end. These sutures were tied and temporarily left long, to serve as traction points. The first suture row was then placed by connecting each of the three points by means of a continuous over-and-over suture through all layers of the viscus. On each side of this first row of sutures other points were selected equidistant from one another on the circumference of the œsophagus. These corresponding points were again joined, but this time by interrupted Lembert sutures through the muscle and adventitia only. These three sutures were tied and the ends again temporarily left long for traction points to facilitate the placing of the second row of sutures, which consisted of interrupted Lemberts through the muscle and adventitia. After this row of sutures had been placed and a water-tight suture line obtained, the tapes were removed from around the œsophagus and a row of tension sutures inserted. These consisted of six interrupted Lembert sutures through muscle and adventitia, each suture taking a long bite of tissue. These sutures were drawn only sufficiently tight to relieve the tension on the first two rows. Thus the anastomosis consisted of (1) a row of continuous sutures through all coats of the œsophagus, (2) a row of interrupted Lembert sutures through muscle and adventitia invaginating the first row, and (3) a row of six interrupted Lembert sutures through muscle and adventitia to relieve tension. All suturing was done with the opposing ends fully dilated in order to minimize the production of stricture. In the neck the external wound was closed loosely. In the chest a strong air-tight closure was employed.

The cervical œsophagus was the site of operation in eighteen dogs by the above technic. Of these nine were successful. They were sacrificed at intervals of from seven to four hundred forty-one days. Only two were sacrificed under three months, as we wished to see the late end results. Of the nine failures, two were poor operative risks, and one had a poor and septic operation as a result of anæsthetizing and operating team mishaps. One of the poor risks died the day of the operation. The other failures died at intervals of one to six days after operation. Most of them had a partially or totally divided œsophagus, and an extensive cervical infection, often with an associated purulent mediastinitis.

The thoracic operation was performed upon nine dogs. Of these three were successes and six failures. The three successful dogs were sacrificed at intervals of 54, 76, and 126 days after operation. All six of the failures had an empyema thoracis. These six unsuccessful cases died at intervals of one, two and three days after operation. In some the suture line was intact, while in others the œsophagus was sloughing at the site of anas-



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tomosis. This variation was found in both the cervical and thoracic anastomoses. At times there would be an apparently perfect anastomosis surrounded by a foul collection of pus, while in other animals we have found an oesophagus pulled apart in an area showing far less extensive signs of infection. Whether this variation was due to difference in blood supply of the oesophagus, to difference in invading organisms or to other factors we do not know.

The end results in the successful cases were remarkably good. All twelve dogs at the time of sacrifice were in excellent condition—even the one



FIG. 3.—See legend under Fig. 1.

killed at the end of seven days. The routine feeding after operation was a quart of milk a day and all water desired for ten days. Then for three weeks they were given a diet of soft food without bones or hard crusts. After that time they received "house diet" in the dog pavillion. When they began to receive solid food it required several weeks for them to learn to chew it properly. At first they would swallow the food pretty much whole and when it lodged in their oesophagus they would regurgitate it and then try again. Gradually, however, they learned to chew bread and bones into small pieces before attempting to swallow them. Still later as the anastomosis probably stretched they were usually able to swallow rather large boluses of poorly masticated food. All the dogs handled the problem, though, and those that were kept for six months to fourteen months stayed decidedly fat.

Of the twelve specimens removed only one showed a marked stricture.

This one (No. 7) had a stricture that would just admit the terminal phalanx of the little finger. Yet as I have said above, this dog was able to stay in excellent condition, and 119 days after operation was well nourished. The condition of this dog was interesting in other respects. At the time of operation a note was made that the musculature of the œsophagus was unusually tender and did not hold sutures well. The specimen at sacrifice showed in addition to the stricture five ulcers in the mucosa at the site of anastomosis, and from each of the ulcers projected a piece of the silk suture used. The mucosa furthermore was markedly discolored and had a distinctly greenish tint. If we had known of this beforehand, it would have been interesting to wait a while longer and to have seen what would have been the course of events. None of the eleven other specimens showed any discoloration. Most of them had slight stricture formation, but in some the site of anastomosis was almost indistinguishable from the adjoining tissue. Most of the specimens had one or more marginal ulcers about the site of the anastomosis, though three specimens showed perfect healing. From each ulcer found there projected a piece of the unabsorbed and unabsorbable suture material used. One of those showing perfect healing was sutured with chromic catgut.

#### DISCUSSION

There are many factors involved in œsophageal surgery. Tension and infection are among the most important. No extensive resection can be done without some plastic substitutive operation. Tension sutures help when an anastomosis is made. Sterilization of that portion of the lumen of the œsophagus that is to be the site of operation is of benefit. Without a tape or some form of pressure on each side of an incision in the œsophagus, saliva from the mouth and gastric contents will be emptied into the wound. In the neck, leaving the external wound open helps to prevent infections that damage the anastomosis and that burrow into the mediastinum. Strictures need not to be feared. The specimens here shown are conclusive evidence that good anatomical and physiological results are obtainable. Our impression is that silk sutures are superior to chromic catgut for this work, even though they result in ulcers. The catgut does not seem to hold long enough constantly, and clinically a piece of silk suture protruding from an ulcer could probably be removed through the œsophagoscope without great difficulty. The blood supply of the œsophagus is poor. That is no doubt partly responsible for what at times appears to be caprice in the obtaining of results. That factor, however, cannot be greatly altered. Infection is in our opinion the problem the solution of which will do most to obtain the "Open Sesame" for obtaining a constant high percentage of good results. We are of the opinion that before thoracic œsophageal surgery is satisfactory, a successful chemo- or bio-therapy, probably an immunological one, will have to be worked out. Possibly an air-tight drainage operation with suction to

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keep the lung expanded will be of use until that time. The prevention of a pneumothorax and the closure of the chest with the lungs fully expanded is now most important, for without doubt the pleura is more subject to infection in the presence of a pneumothorax. This belief about the importance of infection in thoracic work is founded not only on this series of experiments, but upon a later series <sup>‡</sup> also, in which mobilization of the stomach into the chest was done with great care about asepsis. In a large number of these animals (dogs) no hollow viscus was entered, but many of the dogs



10 (32 days)

11 (94 days)

12 (7 days)

FIG. 4.—See legend under Fig. 1.

notwithstanding died of empyema thoracis. Our present knowledge of pleural infections is small. For instance, a few years ago in a laboratory in which I was working, two well-trained surgeons had performed a large series of lobectomies on dogs. They did them in the same laboratory with the same technic, but about eight months apart. The first surgeon did not lose a dog and the second did not save one. It was not a matter of epidemic distemper or mange either. But it was one of infection. Why? None of us could say.

### CONCLUSIONS

1. End-to-end anastomoses of the œsophagus yield an uncertain percentage of successes.
2. When the operation is successful, the anatomical and physiological results are good.

<sup>‡</sup> Done in the Laboratory of the Medical School of the University of North Carolina, but not reported.

3. Any marked stricture at the site of operation can be avoided by doing the anastomosis with the viscus fully expanded.
4. Unabsorbable suture material is probably more satisfactory than cat-gut, though resulting in the formation of marginal ulcers.
5. Scrupulous asepsis is of the first importance in the chest.
6. The prevention of pneumo-thorax at the closure of operation is essential.
7. The development of efficient chemo- and bio-therapy for the control of pleural infection would do most to make operations in this field return a constant high percentage of successes.

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# MALIGNANT DISEASE OF THE THYROID GLAND\*

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A DISCUSSION of any thyroid disorder must soon exhaust established facts and lead us into the depths of the unproven and the unknown, and a study of the malignant aspect would perhaps, at first glance, seem especially fitted to disclose how little we really know about the physiology and pathology of this gland. In many ways our knowledge of thyroid malignancy is incomplete. The true incidence of the disease (in relation to total population, goitrous population, nodular goitre, and geographical goitre belts) has not been worked out; the mortality rate is unknown; the etiological importance of heredity, pregnancy, trauma, infection, and hyperthyroidism, has yet to be established; the histology is still under discussion; the effectiveness of radiation is a debatable point; and methods of treatment are varied and conflicting. And yet, through the Hippocratic process of accurate case reporting, there has gradually accumulated a body of fact which is far from negligible and which offsets to an appreciable degree the undeniable deficiencies in our knowledge.

These records have been rendered accessible and significant to us by the careful analyses and summaries which have been made from time to time by able students of the subject. The most comprehensive reviews are those by Ehrhardt (1902), Müller and Speese (1906), and Wilson (1921).

In his paper, in which he added 290 new cases to the 1140 already reported, Wilson remarked upon the paucity of material from this continent and urged clinicians to bring forward for the common advancement the results of their experience. In what literature has been available to us, we have found reported since Wilson's paper 432 cases, the majority of which have been contributed by surgeons and pathologists. With the 14 new cases reported from the Montreal General Hospital, the total number of cases reviewed in this paper is 1876.

Not only have there been additional reports since Wilson's paper, but decided advances in our knowledge of the subject have been made. The more striking of the newer conclusions will be briefly indicated.

*Pathology.*—Although many writers (Herbst, Graham) include cases of *sarcoma* in their reports, Ewing is doubtful whether its existence has been fully established. Zeckwer reports a case of fibro-sarcoma which will perhaps help to settle the dispute; in his specimen, he states, the fibrils were demonstrated histologically by accepted methods of differential staining.

The growing disbelief in "benign metastasizing goitre" was strength-

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ened by Delannoy and Dhallium's conclusion from an analysis of 72 cases so classed, that few, if any, of the cases had been proved to be benign. This view is shared by Simpson, who urges that, since there is abundant proof of the non-existence of "benign metastasizing goitre," the term should

	Cases
Wilson .....	1430
Graham .....	134
Breitner .....	103
Simpson .....	55
Craver .....	33
DeCourcy .....	24
Klose and Hellwig .....	20
Porter .....	19
Walton .....	13
Hueck .....	9
Eisen .....	7
Wolff .....	3
De Quervain .....	2
Greenfelder and Bettman, Meleney, van Rijssel, Roeder, Delannoy and Dhallium, Kamsler, Kraus, Ashhurst and White, Luney, Zeckwer, each one .....	10
	— 432
Montreal General Hospital .....	14
	— 1876

be dropped. Further support for this attitude is found in the writings of Berard and Dunet, who, with a logic that is typically French, maintain that, even though it is not demonstrable, the primary lesion must be in the thyroid gland.

Graham undertook a review of a large series of malignant cases (134) in the hope of finding better criteria for the histological differentiation of benign and malignant neoplasms. The classical evidence of malignancy, namely, local infiltration, modified cell structure, and karyokinesis, he believes to be inadequate in the diagnosis of certain thyroid neoplasms. The striking observation was made that, by the test of freedom from recurrence, either local or metastatic, 43 tumors which had been classed as malignant, but in which no invasion of blood-vessels by tumor cells had occurred, proved to be benign. On the other hand, invasion of blood-vessels was found in every case which exhibited in its later course clinical evidence of malignant disease. This led Graham to conclude that vascular invasion was the most pertinent histological characteristic of a malignant thyroid neoplasm, and that the most constant single indication of malignant disease was the invasion of blood-vessels by tumor cells.

*Endothelioma* must be given a place among the malignant neoplasms of the thyroid, and current conceptions have been enlarged and clarified by De Quervain's clinical and pathological study under the name of "Struma Maligna Endotheliomatosa". De Quervain believes that this tumor always begins as a localized lesion in the thickened wall of an old cyst.

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Roeder collected 10 cases of *epithelioma of the squamous cell type*. The occurrence of malignant degeneration in benign tumors was made a special study by Speese and Brown.

It would be well here to refer to a rapidly growing tumor occupying the border line between hyperplasia and malignant growth, namely, the *proliferating adenoma* first described by Langhans. The nodules are large, circumscribed, unilateral, rapidly growing, of increased consistence but of normal mobility. Histologically they are composed of solid cellular plaques, arranged parallel to the capsule at the periphery but toward the centre curled upon themselves. With the onset of malignant change the plaques become large and irregular, the capsule and blood channels are invaded, and karyokinesis becomes abundantly evident.

In his paper in 1925, Craver discussed the subject of *parathyroid malignant tumors* and their differential diagnosis. He describes them as small, hard, deeply situated, fixed nodules, attached to one lobe of the thyroid. They develop in slowly growing goitres, are accompanied by dyspnoea, hoarseness, and dysphagia, and do not grow downward toward the clavicle.

Without casting a doubt upon the accuracy of the observations of Klose, Kolodny and others, who have described *metastatic hypernephromas* in the thyroid, a cautious pathologist may well hesitate to pronounce a given specimen a hypernephroma unless the primary tumor can be demonstrated.

While it is true that in the thyroid there are found tumors with a delicate reticulum, vascular channels of a definite type, and large pale quadrilateral cells with small nuclei arranged in groups of fairly equal size, it is perhaps unwise to conclude that they all arise from hypernephromas. One case in our series, reported as a carcinoma (No. 434), presents such a picture in many areas, but careful analysis of other parts of the specimen and the absence of clinical signs of hypernephroma justify the opinion that it was an epithelioma of thyroid origin. Several illustrations in Wilson's paper show sections of tumor which, in certain fields, closely resemble Grawitz tumor.

*Metastases* may make their appearance before the original tumor has been detected (Breitner 4 cases, our series 1 case, No. 389). Walton states that metastases often appear very early and are no contra-indication to operation. Authorities are at great variance as to the commonest site of metastatic implants and the frequency of their occurrence. Kraus, whose series is supported by a large percentage of autopsies, reports the finding of metastases in 90 per cent. of his cases.

*Metastases to bone* have been widely studied. The bone-destroying and bone-forming potentialities of the implants are well known. Joll collected a series of 44 cases of bone metastases associated with normal thyroid or benign goitre. Simpson reviewed 77 cases and, as already noted, his studies led him to believe that the benign nature of the primary growths had not been proven.

True metastases must be distinguished from carcinoma in lateral "aberrant" thyroid tissue, instances of which have been reported by Greensfelder and Bettman, Kamsler, and others.

*Therapy.*—The value of radiation in malignant thyroid disease is a subject of much discussion at the present time. The opinion of Oehler, that the diagnosis of malignant goitre may be verified by the absence of the tracheal shadow in X-ray plates, has been shown to be unreliable by Klose and Hellwig, who quote as authority the writings of Pfeiffer.

Schaedel's belief that thyroid carcinoma is sufficiently radio-sensitive to make exposure a "therapeutic test" has not been widely supported. His statement is that proper exposure of a true cancer to X-rays leads to softening and diminution in the size of the growth in from two to three weeks.

Sarcoma in the thyroid was found by Schaedel to be particularly resistant to X-rays, but Perthes considers the outlook here to be as favorable as elsewhere. According to Schaedel, the primary tumor is more sensitive to radiation than are the metastases arising from it.

Holfelder and Sudeck both state that thyroid malignant neoplasms show greater radio-sensitiveness than do other malignant tumors; and Breitner believes that adeno-carcinoma of the thyroid is more susceptible to radiation than are the other varieties of thyroid carcinoma.

Sudeck, DeCourcy, and others believe that, whenever a clinical diagnosis of malignancy has been made, operation should be withheld and radiation alone employed. Perthes, however, speaking from a very broad experience, recommends radiation as an adjunct to surgical treatment, and in this view he is supported by Holfelder, Werner, Holzknecht, and others.

#### ANALYSIS OF FOURTEEN CASES FROM THE MONTREAL GENERAL HOSPITAL

*Incidence.*—The records of the Goitre Clinic at the Montreal General Hospital (1920–1926 inclusive) cover 1687 cases of goitre, of which 612 were operated upon. Of these 612 cases, 346 were of the adenomatous type. Fourteen cases were malignant, that is 0.8 per cent. of the total number of cases, 1.8 per cent. of the operative cases, and 3.1 per cent. of the adenomatous cases operated upon. These percentages agree fairly well with those of other goitre clinics.

*Age.*—The youngest was fifteen, the oldest fifty-nine. The average age was forty-three years. There were more in the sixth decade than in any other.

In Wilson's series a majority were found in the fifth decade, and Breitner points out that in his series of 103 cases 75 per cent. had passed the age of greatest physiological activity of the thyroid and sex glands.

*Sex.*—There were twelve females and two males, a ratio of 6 to 1. Most writers agree with Wilson that the ratio is more nearly 2 to 1. Breitner had 62 females and 41 males, an unusually high percentage of males.

Considering that, in the 346 cases of nodular goitre operated upon in our clinic, the females outnumbered the males by 9 to 1, there seems to be evi-



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dence that a greater proportion of male goitre cases develop malignancy than do females (5.8 per cent. of males, 3.8 per cent. of females).

*Heredity.*—A history of goitre in ancestors was absent in all cases. Three cases had relatives with goitre. Of other forms of malignant disease in the family there were none in our series. Breitner mentions four instances in his series of 103 cases, and Wolff tells of the occurrence of malignant thyroid disease in two brothers.

*Pregnancy.*—Eight of the twelve women in this series had been pregnant. As most married women become pregnant, however, the importance of pregnancy as an etiological factor requires careful examination. Walton points out that, not only may we expect a parenchymatous enlargement of the gland during or following pregnancy, but that simple adenomas often become larger and harder at this time. In Breitner's paper, however, there is the report of a case in which the onset of the malignancy seems to coincide with the onset of pregnancy. Speese and Brown also quote Kaufman in support of this occurrence.

*Infection.*—A history of infection was not met with in this series, but it is mentioned by Carrel-Bellard, De Quervain, Speese and Brown, and others, as having been present in the history of many cases. The infections reported occurred both in the thyroid itself and in distant regions, and the French writers are particularly insistent upon the frequency of naso-pharyngo-tonsillar infections as an etiological factor.

*Trauma.*—Trauma is mentioned fairly constantly by European clinicians, and in one of the cases here reported trauma preceded the development of a growth which proved fatal in a few months (No. 943).

*Duration of the Thyroid Swelling.*—An increase in the size of the gland was found in all of the fourteen cases of this series. The average duration was eleven years, the minimum one month, the maximum forty years. In only four cases had the swelling existed for more than one year.

The term "acute cancer", used by Craver (who quotes Ewing, Moure and Liebault, and Bowman), designates those rare cases in which growth is amazingly rapid and suffocation threatens within a few weeks of onset. One of our cases has been placed in this class (No. 943).

*Previously Existing Thyroid Tumor.*—In support of the previous existence of thyroid tumor in most cases of malignant disease, if not in all, the opinions of a decisive number of authorities can be cited—Speese and Brown, Wilson, Plummer, Balfour, Berry, Walton, Graham, Klose and Hellwig, and Bland-Sutton. Balfour goes so far as to state that cancer is practically not known to have developed in a previously healthy thyroid gland. Graham states that 90 per cent. of malignant thyroid cases originate in a preëxisting simple or adenomatous goitre.

A history of preëxisting goitre was elicited in 12 cases of our series. In the other two cases it could not be determined from the history whether or not there had been an earlier lesion.

Of the twelve definite cases of preëxisting goitre, five were thought to have been of the adolescent type and seven of the nodular type. Our feeling is that all of these cases were primarily endemic, secondarily benign adenomas, and finally malignant.

There is, however, considerable evidence in favor of the development of carcinoma in the normal gland. Ewing admits its possibility. Hintersoesser's seventeen cases of diffuse infiltration and the well-known peculiarities of the scirrhous group provide a basis for the claim on purely pathological grounds. The clinical studies of Walton, Breitner, and others, include cases of primary cancer. Breitner believes that, in eleven of his cases of carcinoma, the thyroid gland was previously normal. The majority of his cases were males in the fourth decade, with a tumor history of only four months' duration. Fuller data will probably show that this primary type of cancer does occur, but that, in comparison with the number of carcinomas which arise in previously existing lesions, its development is very rare.

*Pain.*—None of the cases in this series complained of either local or referred pain. Breitner and others mention painful sensations in the distribution of the cervical sensory nerves.

*Emaciation* occurred in three cases. Unlike other cancerous growths, thyroid malignancy is rarely accompanied by emaciation. In estimating the rate of failure of nutrition, it is necessary to bear in mind the fact that hyperthyroidism may also be present and, as in our cases, may be the cause of considerable loss of weight.

*Nerve Lesions.*—One case showed paralysis of one vocal cord. This is believed to have been due to interference with the recurrent laryngeal nerve. Walton reminds us that this may result from a benign tumor. In one of Schaedel's cases there was partial motor paralysis of one arm.

*Deformity of the Trachea.*—In six of our cases the trachea was shown by X-ray to be deviated from its normal position. In three cases it was narrowed from side to side. Records of tracheal invasion with hemorrhage and pneumonia are presented by Bland-Sutton and Müller and Speese.

*Dysphagia* was a symptom in one case. Wilson believes that in the early stages it is due to spasm and in the later stages to pressure. Breitner found dysphagia present without dyspnoea or hoarseness. Berry points out the rarity of this symptom in innocent goitre. He observed dysphagia most often in those cases in which the malignant process was situated in the posterior part of the gland.

*Interference with breathing* occurred in six cases. Breitner found this to be the commonest clinical symptom. This embarrassment to normal respiration must be distinguished from the dyspnoea which accompanies exertion in cases of hyperthyroidism or cardiac weakness. In thyroid malignancy the dyspnoea is due to compression and fixation of the trachea or to oedema and invasion of the larynx.

*Rapidly growing thyroid tumor* was observed in four of our cases. While there is a wide difference of opinion as to what constitutes rapidity

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of growth, this term is constantly employed and is useful. In each of our cases the entire growth period was less than one year and the resulting tumor was of considerable size. Herbst includes in this class 25 per cent. of his cases. Wilson, on the other hand, states that rapidity of growth is not necessarily indicative of the existence of malignancy nor of its degree. Loss of fat tissue in the neck emphasizes growths previously inconspicuous or reveals those hitherto unsuspected.

Walton summarizes the causes of rapid increase in size as follows: (1) Proliferation of tissue, (2) hemorrhage, (3) inflammation. It is well to recall that hemorrhage or inflammatory change may occur in benign as well as in malignant tumors.

*Hoarseness* was not observed in any of our cases. In the literature it is mentioned often, and the causes are set down as paralysis of the muscles of phonation, cancerous invasion of the vocal apparatus, or œdema of the cords. The onset may be quite sudden and without increase in the size of the tumor (Breitner).

*Fixation*.—In four of our cases the tumor was fixed to its surroundings and in one case it was fixed to the trachea. This latter feature has often been noted, and Walton insists that it is a sign of paramount importance.

*Consistence*.—The hard "woody" feel of cancerous masses has often been commented upon, but Berry aptly remarks that most small nodules in the thyroid gland are not malignant. Many are calcified adenomata.

*Hemorrhage into the tumor* was not noticed in this group of cases. It does occur, however, and may account for a sudden increase in the size of the tumor, with respiratory obstruction. Hemorrhage of itself is not a proof of malignancy (Berry). Breitner mentions profuse hemorrhage from the œsophagus and trachea, and in simple adenomatous goitre hemorrhage is the most common cause of sudden enlargement, occasionally producing death from suffocation.

*Cardio-vascular changes* were present in five of our cases. The mildest deviation from normal was a transient basal systolic murmur. Three cases had hypertension, tachycardia, and a systolic murmur at the base, and in one patient auricular fibrillation and left preponderance had been present for years.

*Hyperthyroidism*.—Three of our cases had an elevated basal metabolic rate. Walton, Klose and Hellwig, Wilson and Plummer, all subscribe to the statement that hyperthyroidism may be the first sign of malignant change in a benign goitre. Walton removes all nodules which are accompanied by a sudden onset of hyperthyroidism, on the assumption that they will ultimately prove malignant. There is as yet no agreement about the frequency of the occurrence of hyperthyroidism in malignant disease of the thyroid. With the adoption of an elevated basal metabolic rate as the most reliable index of hyperthyroidism, the percentages have tended to rise. Herbst gives 3 per cent., Boothby 22 per cent., and Simpson 50 per cent.

*Graves' Disease*.—There was in our series only one case with the full

Graves' syndrome. The final diagnosis of this case is still in doubt. The tranquil post-operative course and the fact that, two years and one month after operation, the patient is still alive and well, make it seem probable that the morphological picture has led to a false conclusion. Ewing is the authority most often quoted for the statement that the symptoms of Graves' disease may appear during the development of a malignant tumor and that the characteristic hyperplasia of Graves' disease may go on to malignant growth. Herbst, however, failed to find one case of cancer in 5867 cases of exophthalmic goitre.

There were two other cases in our series which exhibited a slight lagging of the upper lid and a widening of the palpebral fissure, but in neither case was there a stare or exophthalmos.

*Point of Origin of the Malignant Process.*—Klose and Hellwig are supported by other European writers in the statement that malignant change originates more often in the right lobe than in the left.

*Metastases* were noted in four of our cases. They occur perhaps more frequently than one would conclude from reports; in 14 of Breitner's cases they were missed clinically and detected only at autopsy. In our cases they all occurred in the tissues or lymph-nodes immediately surrounding the thyroid.

Recurrences took place in four of our cases. This is a common experience. In three of these cases a previous operation had been performed elsewhere.

*Invasion of Blood-vessels.*—Although in this clinic the invasion of blood-vessels has been looked for only since the appearance of Graham's article, it has been demonstrated in four of our more recent cases, one of which has since died. The gross invasion of large vessels has, of course, always been recognized, and Breitner includes seven cases in his series.

Other venous lesions are (1) venous stenosis and thrombosis (Craver); (2) venous invasion where the tumor capsule is intact; and (3) venous invasion by a histologically benign tumor (Ewing).

*Clinical Diagnosis.*—Only six of the cases included in this report were diagnosed clinically (four advanced), a percentage corresponding with those given by other observers. Some solace is found in De Quervain's statement that, "when malignant degeneration exists in a well-encapsulated goitre, clinical diagnosis is out of the question." Balfour's statement, that the majority of cancers develop deep in the gland and not at the surface, also accounts for many failures. Balfour's observation coincides with our own experience.

De Quervain points out that, in a non-pregnant patient past the age of thirty, rapid growth in a goitrous nodule should arouse suspicion. Walton stresses the irregularity of outline, the increase in consistence, and the development of signs of hyperthyroidism, but Klose and Hellwig think that the mass need not be nodular, and Friedland describes a series of carcinomas without any enlargement of the gland.

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There is, of course, no difficulty in diagnosing a tumor which grows rapidly, is fixed and hob-nailed, causes pain, and is associated with glandular enlargement; but the writings of Kocher and Berry suggest that few clinicians have the refinement of diagnostic skill necessary to detect the early cases or to determine whether or not there is malignant change in small nodules. Undoubtedly, were the examination of patients less perfunctory, more cases would be recognized or suspected before glandular metastases had occurred.

With regard to local recurrences, we now take the view that a nodule developing in a lobe upon which a previous enucleation resection has been performed, with negative histological findings, should be considered malignant until proved otherwise.

*Diagnosis at operation* was made in two of our cases. The likelihood of an accurate diagnosis being made at operation in hitherto unsuspected cases is rather meagre.

*Histological Diagnosis.*—Four of our cases were diagnosed histologically, and two were overlooked by the pathologist and recognized later by recurrences. The importance of skill and vigilance in the microscopical examination of all tissue removed can not be over-estimated, and, although errors of omission and commission do occur, the progress of histological diagnosis is decidedly in the direction of greater efficiency.

*Differential Diagnosis.*—Berry, De Quervain, and Kraus, agree that the most difficult clinical differentiation is that between thyroid malignancy and chronic diffuse thyroiditis. In the latter condition there is a dense, uniformly hard swelling, of moderate size, generally unilateral at first, but soon involving the whole gland. The gland moves freely on deglutition, is usually somewhat fixed to the trachea, nearly always painless, and practically without symptoms. The two most important differential points are: (1) the smoothness of the surface of the gland, the normal shape being retained, and (2) the early waxy pallor of the patient (myxedema). Dysphagia is rare.

Tertiary syphilis may be excluded by the clinical history and the Wassermann test.

Tuberculosis is rare. In its nodular form the foci undergo softening and form abscesses. In one of our clinic cases, a woman with an enlarged thyroid, indurated glands in both posterior triangles, and an elevated basal metabolic rate, malignancy was suspected. A resected lymph-gland was shown to be tuberculous, and the thyroid nodules on resection were found to be simple adenomata.

Worthy of note are those cases cited by De Quervain of old cystic goitres with thick walls, in which hemorrhage or metastatic infection had occurred.

In the absence of fever or leucocytosis, immobility in a tumor and a recent increase in size should, in patients over forty, raise suspicions of malignancy.

To Trotter we owe a pertinent discussion of the differential diagnosis

between carcinoma of the cervical œsophagus and thyroid gland malignancy. He states that in œsophageal cancer there is first weakening of the voice; secondly, enlargement of the thyroid gland due to induration of its posterior surface; and thirdly, œsophageal symptoms. A case observed at the Montreal General Hospital in 1923 supports this view. A man, aged fifty-eight, was forced to give up his occupation as an announcer and interpreter in a cinema on account of loss of voice. Physical examination revealed a hard enlargement of the thyroid gland and œdema of the vocal cords. Barium films of the œsophagus were negative. He failed rapidly and died, and at autopsy a small carcinoma was discovered in the œsophagus, with metastases about the larynx and in the thyroid.

We are indebted to De Quervain also for the following remark in regard to differential diagnosis: "Operation must never be delayed until all the signs of malignancy are present, because the aim is not diagnosis, but cure. The prognosis in malignant goitre is favorable only so long as the growth is within the capsule of the goitre, and malignancy must, therefore, be suspected rather than diagnosed."

*Treatment.*—Opinions on treatments are very varied. Kocher states that a "really early" operation will cure from 80 to 90 per cent. of cases, but the value of this statement depends upon what is meant by "really early". Balfour and DeCourcy think that, if a clinical diagnosis can be made, there is little hope in operation alone, and advise radiation too. There are advocates of radiation alone who claim results superior to those achieved by surgical removal. Others, again, believe that radiation alone should be used only in inoperable cases; Breitner had six cases who lived for more than three years and Weber also reports successes. The experience of Heyerdahl with radium alone (eight cases, of which five were improved and three unimproved) compares unfavorably with the results obtained by others. Pfahler advocates radium if X-ray fails.

Most surgeons agree that, in the conduct of reasonably early cases, the "golden middle way" is thorough operation followed by radiation, the only controversial points being the extent of the operative procedure and the variety and amount of radiation. Breitner's post-operative use of frequent and small doses of X-rays is in contrast to the more recent recommendation of large doses with long intermissions.

Sixteen operations were performed upon 11 patients in our series:

Unilateral lobectomy .....	6
Subtotal thyroidectomy .....	4
Unilateral lobectomy and removal of metastases .....	2
Excision of metastases .....	2
Bilateral partial lobectomy .....	1
Bilateral partial lobectomy and removal of glands .....	1
	—

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Tracheotomy was not performed in any case.

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<i>Operative Results.</i> —Operative death .....	0
Deaths since operation .....	2
Not seen since discharge .....	1
Living .....	8
	<hr/>
	11

Of the cases who were not operated upon, one died three weeks after discharge from sudden suffocation after going upstairs; one did not return to the clinic; and the third (an out-of-town case) has not been heard of since examination. Both are presumably dead.

Of the eight cases known to be alive (57 per cent.) the post-operative period varies from five weeks to five years.

Less than one year post-operative .....	3
Between one and two years post-operative .....	1
Between two and three years post-operative .....	2
Between four and five years post-operative.....	2
	<hr/>
	8

It would be hazardous to pronounce any of these cases complete cures, but in a few of them the results are extremely gratifying. Simpson finds that the five-year period is not long enough to pronounce a cure.

Craver found that the average age at diagnosis of those cases who died was higher than that of the living and the average duration of the tumor was also much greater in those who died than in those who survived.

A second operation was performed in two of our cases, and a third operation in one case. This last patient is still alive, four years and two months after the first operation, and is at present without evidence of disease.

<i>Histological Classes</i> —Malignant adenoma .....	2
Carcinoma .....	8
Malignant papilloma .....	1
No histological diagnosis .....	2
Doubtful .....	1
	<hr/>
	14

If sarcoma does exist in the thyroid gland, it is certainly the most deadly of the histological varieties of malignant disease. Of those cases reported by Breitner not one survived more than four months, and, in spite of sundry opinions to the contrary, sarcoma would seem to be less radio-sensitive than are the other malignant neoplasms in this organ.

Both of our cases of malignant adenoma are alive, the one—three months after operation, the other—one year after. Herbst found that 17 per cent. of his cases lived at least five years.

Of the cancer cases four are alive and four are dead. The living cases are from two months to five years post-operative. Herbst reports 5 per cent. of five-year cures in this class.

Malignant papilloma is regarded as the least malignant variety, and of

these Herbst reports 33 per cent. of five-year cures. The case reported here is alive, but only two months have elapsed since operation. Malignant papilloma is said to grow slowly, to give rise to small local recurrences, and to involve the lymph-nodes very late.

The case of exophthalmic goitre in this series (No. 1045), with hypertrophic parenchyma profusely invaded by epithelial masses, extensive vascular invasion, intense lymphoid reaction, and a deeply embedded adenoma (treated by subtotal thyroidectomy in two stages), is still alive and well, two years and one month after operation. The correctness of the histological diagnosis of malignancy must now be considered doubtful.

CONCLUSION.—During the past five years progress has undoubtedly been made in the diagnosis and treatment of malignant disease of the thyroid gland, but, where the condition is advanced and there is infiltration of the surrounding structures or extensive cervical glandular metastases, there is still little hope of a permanent cure. The results obtained, however, in those cases operated upon under suspicion of malignancy or in those in which unsuspected malignancy is discovered at operation, are distinctly more encouraging. Still better results may be confidently forecast from the extension of our knowledge of radiation, its more general use in those cases in which the malignancy is recognized or discovered before the occurrence of metastases, and the more frequent and early removal of nodular goitres.

#### CASE REPORTS

(1) Clinic number 389. Male, aet. fifty-seven. Admitted May 12, 1922, complaining of palpitation, weakness, and loss of weight. He gave a history of having had "a small gland" removed from the left submaxillary triangle one year previously. Emaciation, tremor, rapid irregular pulse, and muscular weakness were the outstanding clinical features. The basal metabolic rate was +47. Weight, 133. The electrocardiogram showed auricular fibrillation. There was a movable, globular mass, 6 cm. in diameter, occupying the lower pole of the left lobe of the thyroid. Clinical diagnosis: toxic adenoma.

On June 1, 1922, under local anaesthesia, enucleation resection of the left lobe was performed. Pathological diagnosis: "Adenoma".

Following operation the tachycardia subsided and the basal metabolism fell to normal. The patient returned to work on September 5, 1922, as a hydrant inspector. By November 15, 1922, the weight had risen to 190 pounds. In September, 1924, he began to lose weight. On October 23, the basal metabolism was found to be +58, and on November 6, +78. At this time the appearance of enlarged glands on the left side of the neck was first noted. Later they were found on the right side.

The patient was re-admitted on December 18, 1924, and bilateral dissection of the lymph-glands of the neck carried out under local anaesthesia. The left internal jugular vein was removed. Pathological diagnosis: Adeno-carcinoma of thyroid origin. X-ray treatments.

The patient remained well for eight months. He was then admitted with failing circulation and gangrene of the feet. Died December 5, 1925. No autopsy.

(2) Clinic number 414. Female, aet. fifteen. Unmarried. Admitted January 7, 1923. History of goitre at age of ten, which disappeared on application of iodine, but recently recurred. On admission there was general enlargement of the gland, with



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an adenoma in the upper pole of the right lobe. There were no symptoms of hyperthyroidism. The basal metabolism was minus 5. Diagnosis: Adenoma non-toxic.

Operation January 12, 1923, under local anaesthesia: Bilateral partial lobectomy, an adenoma being found in the left lobe as well. Pathological diagnosis: Multiple adenomata. Uneventful recovery.

On October 22, 1924, the patient returned, complaining of a lump in the neck, present for three months. On examination there was found a mass  $2\frac{1}{2}$ -3 cm. in diameter in the right anterior triangle, on a level with the hyoid bone, freely movable, but no movement on swallowing. Temperature  $99\frac{1}{2}$ °. The possibility of a tuberculous cervicitis was at first considered. The tonsils were cryptic. There was general pyorrhoea. On November 19, 1924, the mass was noted to be definitely larger.

On January 6, 1925, under local anaesthesia, a number of glands with infiltrated capsules were removed from the right anterior triangle. On section these glands suggested thyroid metastases. This diagnosis was confirmed in microscopic sections. This operation was followed by X-ray treatments.

On April 22, 1925, there were palpable glands to be made out along both jugular veins, more marked on the left side at the level of the thyroid. Up to this time the patient had had six X-ray treatments. On October 2, 1925, the glands on the left side were noted to be larger and admission was advised.

On December 26, 1925, the patient was re-admitted, and on December 31, under intratracheal insufflation, all glands from the base of the skull to the clavicle were removed on the right side, together with the remnant of the right lobe and isthmus, as well as the internal jugular vein. In addition the remnant of the left lobe was explored and a portion removed. The thyroid tissues removed showed microscopically adeno-carcinoma. The lymph-nodes removed were free from metastases. Recovery uneventful. X-ray treatments have been continued. The patient is alive and well, four years and two months after the first operation.

(3) Clinic number 426. Female, aet. fifty-three. Married. History of goitre of seven years' duration. Clinical diagnosis: Adenoma of the right lobe. No toxic symptoms.

On March 25, 1922, under local anaesthesia, practically the whole of the right lobe was removed from within the capsule, together with a gland attached to its lower pole. Histological diagnosis: Carcinoma of the thyroid, with complete replacement of lymph-nodes with thyroid tissue. No X-ray treatment. Has remained well (five years after operation).

(4) Clinic number 434. Female, aet. twenty-eight. Unmarried. Admitted April 18, 1923. History of adolescent goitre, developing at the age of fourteen and slowly increasing in size. Previous operation elsewhere six years before. On examination there was found moderate enlargement of the left lobe, with fixation. Patient underweight. No toxic symptoms. Diagnosis of carcinoma made before operation and confirmed by pathological examination of tissue removed.

Operation April 23, 1923, under intratracheal insufflation. Removal of left lobe, with dissection of neck and removal of internal jugular vein. The growth was found to be adherent to the left side of the trachea, to the margin of the oesophagus, and to the pre-thyroid muscles on the left side. The latter were removed. Uneventful recovery. Discharged May 5, 1923. Not heard from since. No response to follow-up letters.

(5) Clinic number 689. Female, aet. fifty-two. Married. Admitted August 14, 1923, with enlargement of the thyroid of two and a half months' duration. Pressure symptoms had been present for six weeks and there was frequent cough. There had been a loss of twenty-six pounds in weight in four months. Diagnosis of carcinoma was made before operation.

Operation was performed August 21, 1923, for relief of pressure, subtotal thyroidectomy under local anaesthesia. Evident involvement of the mediastinal glands. Clinical

diagnosis confirmed by microscopic examination. X-ray treatments given. Patient died some months later.

(6) Clinic number 943. Male, aet. forty-nine. Admitted November 12, 1924. History of blow on neck five months previously, followed by rapidly growing hard tumor of neck. Clinical diagnosis: Carcinoma of the thyroid. Confirmed by microscopical examination of a gland removed from the left posterior triangle of the neck. The growth was advanced. Trachea fixed. There were stridor and paralysis of one vocal cord. No operation. Died suddenly three weeks later, from suffocation after going up-stairs. No autopsy.

(7) Clinic number 994. Female, aet. fifty. Married. Admitted January 7, 1925, with a small nodular enlargement of the thyroid, extending down behind the manubrium. Very little movement of the trachea on swallowing.

Enlargement first noted only four weeks before admission. Clinical diagnosis: Carcinoma, inoperable. X-ray treatments advised. Patient did not return to the clinic. No response to follow-up letters.

(8) Clinic number 1014. Female, aet. thirty-eight. Married. Admitted November 12, 1925. History of goitre for two years. Diagnosis of carcinoma with lymph-gland metastases made at operation November 14, 1925. The isthmus and the left lobe, with capsule, parathyroids, and left recurrent laryngeal nerve, were removed, together with the left prethyroid muscles, the lymph-glands in the anterior and posterior triangles of the left side of the neck, and the left internal jugular vein. Uneventful recovery. Permanent impairment of phonation. Intermittent X-ray treatments. Living and well two years and four months after operation, with no clinical signs of recurrence.

(9) Clinic number 1045. Female, aet. forty. Married. Admitted December 10, 1924. History of goitre for five years. The patient presented all the symptoms of Graves' disease, in an exaggerated degree. The basal metabolism rate was +90. The thyroid was uniformly enlarged, the surface of the lobes smooth.

Right lobectomy was performed under gas-oxygen anaesthesia on February 11, 1925. In this lobe was found an adenoma, about  $1\frac{1}{2}$  cm. in diameter—a lesion not previously suspected.

On March 6, 1925, the left lobe was removed under gas-oxygen. The microscopic examination showed hypertrophic parenchyma profusely invaded by epithelial masses, with intense lymph-cell invasion and invasion of the blood-vessels. Diagnosis: Malignant. Uneventful recovery. X-ray treatments advised, but none given. The patient is well, more than two years post-operative.

(10) Clinic number 1048. Female, aet. fifty. Married. Admitted March 18, 1926. History of slowly growing goitre of forty years' duration, with dysphagia, stridor, and loss of weight during the previous year. The trachea was displaced to the left by a very large, hard, nodular tumor of the right lobe of the thyroid. The moderate degree of fixation seemed to be due to the size of the tumor. Clinical diagnosis: Carcinoma in previous simple adenoma.

Operation March 22, 1926. The whole of the right lobe was removed without injury to the recurrent laryngeal nerve. There were no enlarged lymph-nodes. Clinical diagnosis of malignancy confirmed by microscopic examination. Two X-ray treatments given before discharge. Patient has since remained well and free from evidence of metastases.

(11) Clinic number 1421. Female, aet. thirty-eight. Married. Admitted July 8, 1926, with a history of goitre for fifteen years. Partial removal five years ago elsewhere. Examination showed a very large nodular goitre, with deviation and displacement of the trachea to the left, with compression.

Operation July 13, 1926. Local anaesthesia. Bilateral enucleation resection. Malignant adenoma diagnosed histologically. Post-operative radiation.

Alive and well nine months after operation, without evidence of recurrence.

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(12) Clinic number 1772. Female, act. thirty. Married. Admitted January 9, 1927. History of nodular goitre, of moderate size, for six years. Operation January 12, 1927, under local anaesthesia. Bilateral enucleation resection. Malignant papilloma invading blood-vessels discovered pathologically. No X-ray treatments to date.

(13) Clinic number 1771. Female, act. forty-two. Unmarried. Admitted March 5, 1927, with a history of thyroid enlargement for thirty years. On examination there was found a freely movable, diffusely nodular goitre. Enlargement more marked during the last few months. There was moderate hyperthyroidism. The basal metabolic rate was +24. Operation March 10, 1927. Bilateral enucleation resection. Carcinoma of the left lobe suspected at operation and demonstrated in sections. Post-operative X-ray treatments.

(14) Clinic number 1773. Female, act. fifty-seven. Married. History of adolescent goitre at fifteen, which receded. Goitre reappeared at age of thirty. In October, 1926, had operation upon the thyroid elsewhere. Examination showed a very large fungating necrotic tumor, extending across the front of the neck. Inoperable. No treatment. No histological examination. No subsequent report.

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# THE SECONDARY SYMPTOMS OF EXOPHTHALMIC GOITRE (GRAVES' DISEASE)

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THE cases of exophthalmic goitre admitted to this clinic in the past two years have frequently failed to show the cardinal symptoms of the disease as generally stated. The cardinal symptoms occurring in their chronological order are, first: tachycardia; second: tremor; third: enlargement of the thyroid; fourth: exophthalmos. We have observed forty-two cases of exophthalmic goitre during this period. Of the cardinal symptoms exophthalmos is the least frequently encountered, as this makes its appearance fairly late in relation to the other complaints. This was absent in sixty per cent. of the cases. Enlargement of the thyroid was seen in seventy per cent. of the cases. In the very early stages the enlargement cannot be detected, but it may appear during the crisis and disappear in the remission. The other cardinal symptoms are constantly present in any case of exophthalmic goitre. The secondary symptoms are of more importance in making a diagnosis during the early stages of the disease than the above stated cardinal symptoms. For that reason more stress should be placed on these than has been done in the past.

(1) *Restlessness*.—This is frequently one of the early symptoms particularly noticed at the beginning of the disease. It is difficult for the patients to remain still, and during a conversation they are continually moving their hands and feet, or adjusting their clothing. The patients are usually unaware of their restlessness, but it is noticed by members of the family or friends. (2) *Irritability*.—Members of the family notice that the patient who before the onset of the disease had a very even temper, and maybe even a phlegmatic disposition, suddenly becomes very difficult to live with and constantly quarrels on the slightest provocation. The patient will tell you that members of her family cause her to lose her temper which never occurred before the start of the present condition. (3) *Emotion*.—The patient becomes very changeable and may cry or laugh from the slightest cause. This is not seen as early as the other nervous manifestations of the disease. (4) *Vaso-motor Disturbances*.—If the patients are carefully questioned one will find that they can stand much more cold than they could before the onset of the disease. They usually state that they wear less clothing than they did and are uncomfortable in a room which is comfortable to others. Their skin is moist and flushed. This becomes much more marked on the slightest exertion or excitement. (5) *Palpitation*.—This is a very distressing symptom. It is entirely different from tachycardia, and should not be confused with the latter. A normal individual is not aware of the heart action. Palpitation

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usually follows the slightest exertion and quite frequently comes on at night. It is also one of the factors in causing insomnia. This condition does not bear any relation to the severity of the disease, and the mild cases complain of this symptom as much or more than the severe types. (6) *Appetite*.—The usual complaint is an increase in the appetite. Patients who had only a fair appetite before the onset of the disease will complain of a ravenous one. In spite of the increased appetite they are steadily losing weight. Anorexia is occasionally complained of, but this is encountered in those cases that put on weight during the disease. These cases are seldom seen but do sometimes occur. We have encountered only two cases in which there was a definite gain in weight, one patient having put on twenty-five pounds and the other forty pounds, both being young females, the former twenty-one and the latter nineteen. Each diagnosis was proven by histological examination. (7) *Menstrual*.—The menstrual cycle is altered, the first symptom being a diminution at the time of the normal period. Later the time between periods lengthens and one may be skipped, and in the final stages the patient may have complete amenorrhœa. (8) *Sexual*.—The libido may be either diminished or lost. This is more often seen in males and is a very distressing symptom and frequently is the chief worry of the patient. Of course, this is transitory and will be relieved after the hyperthyroidism is cured. (9) *Insomnia*.—This is worse in the early morning hours. The patient falls asleep in the early part of the night but awakens after a few hours of sleep. Palpitation seems to be a factor in insomnia. This is not generally seen during the early stages of the disease. (10) *Muscle Fatigue*.—The patient frequently complains of being as tired in the morning as on retiring. Rest does not seem to relieve the exhaustion. Weakness of the extremities is sometimes seen, and occasionally a sudden giving away of the knees is encountered. The patient may drop while standing from no apparent cause whatsoever. (11) *Hyperhidrosis*.—The patients will complain of perspiring freely and are bothered more from their hands and feet than before the onset of the disease. Exercise or exertion does not seem to play any particular part in this condition. (12) *Pains*.—It is not uncommon for the patient to complain of vague pain in the extremities, joints and back, and this may be the primary factor for which medical relief is sought. I can cite one case whose chief complaint was referred to a sacro-iliac strain, for which he had worn numerous belts and braces for two years without relief. Since a thyroidectomy he has never had any complaints referable to the back and has been doing manual labor since five weeks following the operation, which was four years ago. (13) *Hoarseness*.—Quite frequently the patient will suffer from hoarseness, which seems to be due to a selective action of the thyroid secretion on the laryngeal nerves, producing a neuritis which will clear up following thyroidectomy. (14) *Falling of Hair*.—This is occasionally seen in the disease being confined as a rule to small areas of the scalp, and not affecting the entire coat of hair. (15) *Pigmentation of the Skin*.—Bronzing of the skin is seen. When encountered it is confined to the exposed portion of the body, chiefly the face, neck and arms, and is usually localized in patches.

# PHLEGMONOUS GASTRITIS

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AND

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PHLEGMONOUS gastritis is a condition of very great interest because of its rarity and because of the high mortality. Brumm<sup>1</sup> was able to find two hundred and nineteen cases reported in the literature up to 1925.

Historically this condition has been known for a long time. Galen is said

to have described the condition. Shatara<sup>2</sup> stated that Benel in 1656 was the first to really describe the condition.

Pathologically the affliction is an acute purulent infection confined to the submucosa of the stomach, anywhere from the pyloric ring to the cesophagus and not usually extending beyond these confines. It may extend to the muscularis and the serosa but the mucosa is not usually involved. The affected portion of the stomach becomes markedly cedematous and the stomach wall may enlarge to four times the natural thickness. The serosa is

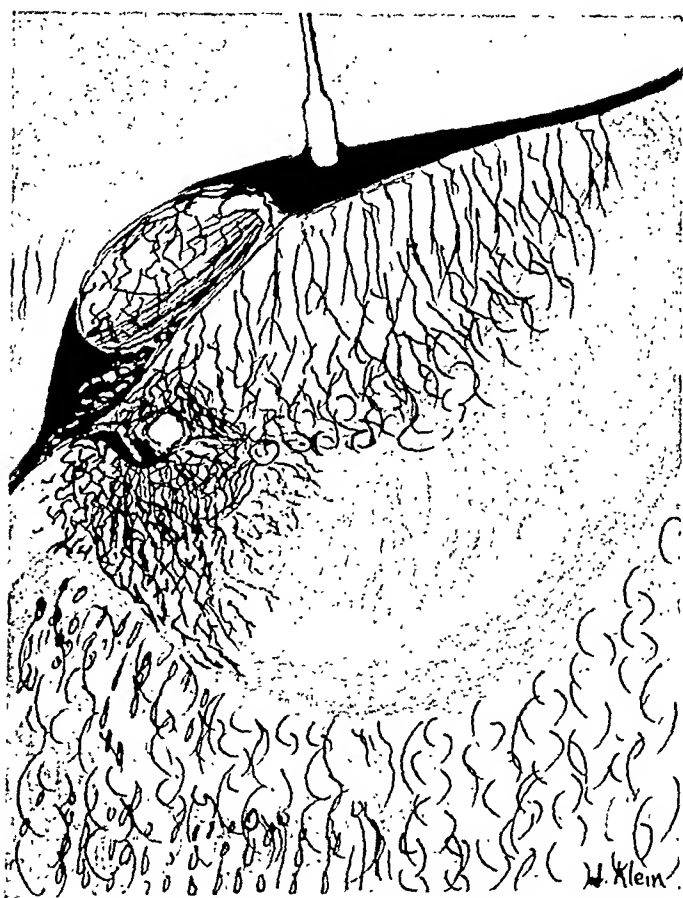


FIG. 1.—Condition at operation. Perforation in ulcer area. Purulent mass extruding.

injected and there may be a fibrinous exudate. The submucosa is distended by a purulent infiltration. The process may be either diffuse involving most of the stomach or it may be quite localized and circumscribed. The course of the condition usually terminates fatally in unoperated cases, death being due to general peritonitis or septicæmia.

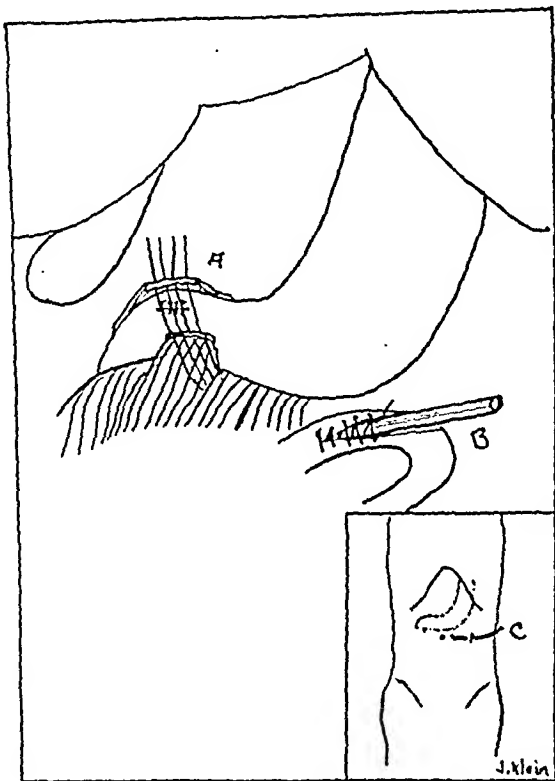
*Etiology.*—Phlegmonous gastritis seems to affect males more than females, especially between the ages of twenty to sixty years. (F. Stöhr.<sup>3</sup>) Chronic alcoholism is a predisposing factor stressed quite frequently in the



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literature. Bacteriologically the most common offender was the streptococcus. This organism was obtained in pure culture from seventy-five per cent. of the cases reported in the literature; the rest were mixed infections with staphylococci, diplococci, B. Coli and occasionally the pneumococcus. (Brumm<sup>1</sup>.)

*Pathogenesis.*—The malady may arise from a local lesion in the stomach or through the blood stream. Brumm stresses the point that we see gastric phlegmon only where there is an absence or diminution of gastric acidity. This condition exists frequently in chronic alcoholism, carcinoma, chronic peptic ulcer, cirrhosis of the liver and severe anæmia. Thus twenty-five per cent. of the patients in the literature were chronic alcoholics. Brumm grew twenty-four-hour cultures in broth of virulent streptococci and placed some in normal gastric juice, some in hyperacid peptic secretion and some in anacid secretion. He found that the streptococci thrived in the latter secretions but were killed in the acid juices. This explains the failure of Shatara<sup>2</sup> to infect dogs by feeding them bacteria mixed with ground glass. The acidity of the normal gastric secretions prevented the infection. The disease may arise secondary to typhoid fever, scarlet fever, small-pox, puerperal fever, and even acute tonsillitis.



A. Suture line . . . . . longitudinally. Gastro-hepatic an . . . . . being sutured over the ulcer . . . . . C. Position of jejunostomy tube at the level of umbilicus.

(Brooks and Clinton<sup>4</sup>.) "Phlegmonous gastritis may result either from some local process in the stomach, especially if there is low gastric secretion or from generalized bacteriæmia. (Meyer, Brams and Guy<sup>5</sup>).

*Symptomatology.*—The onset usually is sudden with excruciating pain in the abdomen, vomiting, fever, and marked abdominal rigidity. Sometimes the patient vomits pus (Sundberg,<sup>10</sup> Boas<sup>4</sup>); this is very significant but not common. (Meyer, Brams and Guy<sup>5</sup>.) The pain resembles that of perforated peptic ulcer. In short, the picture is that of an acute abdominal catastrophe and in only a few instances has the diagnosis been made during life. (Chvosok, Dörbeck, McCaske. )

"The disease so seldom comes within the domain of the practical surgeon that unless he has previously met with such a case he is unlikely to make any other diagnosis than that of some urgent condition in the upper abdomen requiring exploration." (MacCauley<sup>6</sup>.)

It is thought that the following case is of sufficient interest to be recorded

because of some of the characteristic etiological factors as described above, because of the conservative surgery attempted, and because of the recovery of the patient.

**CASE I.**—Thomas Mickey, aged thirty-seven years, single, clerk. The patient was seized suddenly on the morning of May 12, 1927 with acute abdominal pain about the umbilicus. There had been some vomiting before the physician arrived. The patient was seen to be in marked shock and had the anxious look and gray pallor of a severe abdominal catastrophe. General physical examination showed alopecia areata, marked pyorrhea, heart and lungs apparently normal. The abdomen, however, was very rigid with most of

the rigidity over the right epigastrium. There was most marked tenderness on pressure over the right epigastrium, although patient complained bitterly of pain all over abdomen on palpation.

*Past History.*—The patient had been a faithful and steady user of alcohol for the past eight years. For the past six years the patient has suffered from periodic attacks of epigastric pain which was relieved by food taking and by soda. For ten days prior to the acute attack the patient had been feeling rather ill and had been vomiting but he had attributed this to the use of moonshine, of which he had been partaking liberally. On morning of acute attack he "felt something snap inside", then felt the excruciating pain which led him to call a physician.



FIG. 3.—T. M., June 6, 1927. Post-operative view of stomach and jejunostomy.

*Past Illness.*—Scarlet fever as a child. Influenza in 1918. History of gonorrhoea and chancroid. Lues denied. Temperature ninety-six degrees. Pulse eighty. Respiration twenty-eight. White blood count 17000. Urine negative. Blood Wassermann (obtained afterwards) negative.

The high lights in this clinical picture are: history of alcoholism; apparent ulcer syndrome for the past six years, and the sudden onset of severe abdominal pain. A diagnosis was made of ruptured peptic ulcer.

The patient was immediately admitted to the Washington Park Hospital where under ethylene-ether anaesthesia the upper abdomen was opened by an incision in the right epigastrium. On opening the peritoneal cavity free pus escaped. Then it was noted that the upper abdomen was bathed in greenish-yellow pus, which seemed to be coming from under the liver and from the lesser peritoneal cavity. The gall-bladder was apparently normal, except for injection of the serosa and plastic exudate. On examining the stomach it was found to be markedly thickened and oedematous, especially in the pyloric portion involving at least half of the stomach. On the lesser curvature near the pyloric ring there was evident a markedly indurated area the size of a half-dollar in the centre

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of which was a perforation from which was half extruded a necrotic plug of material similar to that seen in a furuncle. On removing this plug of necrotic material pus exuded from the submucosa and it was seen that the mucosa was lifted up and rolled over but not otherwise affected. The stomach wall at the site of the perforation measured about one inch in thickness. A portion of gastro-colic omentum was found plastered down over part of the indurated area, an attempt at a natural defense. Because of the poor condition of the patient and the markedly œdematous stomach wall in the presence of an infected field, resection was thought inadvisable. The perforation was sewed over with interrupted sutures through the serosa and submucosa, attempting to invert same. The gastro-hepatic and gastro-colic omenta also were brought together covering the entire area that was indurated and again covered with a portion of the great omentum. Instead of performing a gastro-enterostomy we performed a jejunostomy after the Witzel method pulling up a loop of jejunum through a stab wound made at the level of the umbilicus and one and one-half inches to the left. A No. 18 French rubber catheter was sewed into the jejunum after the Witzel method. One drain was placed down to the foramen of Winslow, another down to the pyloric part of the stomach, and a third down to the pelvis. The abdomen was then closed in the customary fashion. Condition after operation fair.



FIG. 4.—T. M., June 6, 1927. Post-operative view of stomach and jejunostomy.

*Course in the Hospital.*—The patient vomited up some greenish pus for several days after the operation. His general condition seemed improved and he was relieved of his excruciating pain. In doing the dressings it was noted that the drainage material had a fecal odor, probably due to contamination with *B. Coli*. The jejunostomy tube was connected up with a Murphy drip apparatus and the patient was fed constantly through this. Following are some extracts from the hospital record.

May 13, 1927.—Temperature 100.2 degrees. Pulse 114. Respiration 28. Normal saline by drop method through jejunostomy tube. Patient vomited greenish pus frequently.

May 14, 1927.—Temperature 99 degrees. Pulse 84. Respiration 28. Glucose (5 per cent.) in normal saline through jejunostomy tube.

May 15, 1927.—Temperature 99 degrees. Pulse 64. Respiration 20. General condition good.

May 16, 1927.—Milk 500 c.c., water 500 c.c., Karo syrup 50 c.c., administered through tube.

May 24, 1927.—Water by mouth for the first time, one ounce every four hours.

May 26, 1927.—One ounce milk added to diet by mouth.

June 2, 1927.—Milk and cream, two ounces each given by mouth.

June 5, 1927.—Temperature 98.6 degrees. Pulse 80. Respiration 24. Discharged on the twenty-fourth day, feeling well.

The patient was now examined röntgenologically. There was hyper-peristalsis noted in the fluoroscopic examination. The region of the pylorus was still extensively scarred. (See X-ray films.) The jejunostomy tube was still in position in the jejunum. This was now taken out and the wound healed very rapidly. Subjectively the patient feels quite well and has been put on an ulcer régime.

Surgical procedure in phlegmonous gastritis will depend on the state

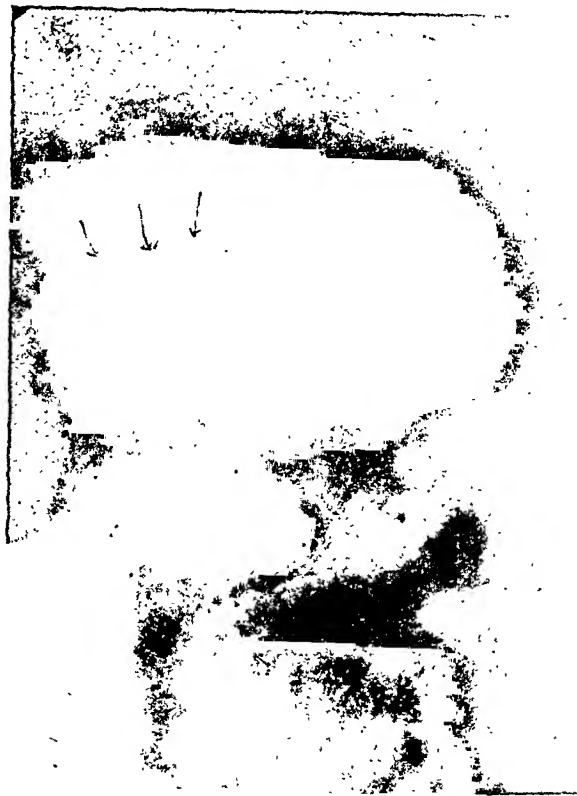


FIG. 5.—T. M., June 6, 1927. Post-operative view of stomach and jejunostomy.

of affairs found at operation. In the localized form resection is advised by various authors, the stomach then being united to the jejunum. (Meyer, Brams, and Guy.) In the diffuse form multiple punctures of the stomach wall is advised in the hope of permitting free drainage. A new procedure is recommended here, no mention of which is seen in the literature. Since death in this affection is due mainly to peritonitis and since it is rather difficult to drain the entire stomach submucosa by ordinary methods, it is suggested

that the stomach be brought out on the abdomen as is done in Mikulicz operations in malignancy of the colon. However, the circulation should be preserved intact; multiple incisions should be made in the submucosa and the stomach kept warm and moist with normal saline solution. This procedure would make some reasonable attempt at keeping the infection out of the general peritoneal cavity. The patient may be fed through a jejunostomy as was done above.

#### CONCLUSIONS

1. A case of localized phlegmonous gastritis is reported on the basis of an old peptic ulcer in the presence of chronic alcoholism and pyorrhea. Closure of perforation, drainage, jejunostomy, recovery.

2. In the diffuse form it is recommended to bring the entire stomach out on the abdomen as in Mikulicz operations and multiple incisions for drainage

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be made, at the same time attempting to preserve the circulation. The patient should be fed through a jejunostomy.

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# SIDE-TRACKING OPERATIONS FOR BILE DUCT OBSTRUCTION\*

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THE side-tracking operations for common or hepatic duct obstruction is a palliative procedure designed to carry the bile into the upper gastro-intestinal tract in the presence of an irremovable duct obstruction or irreparable duct injury. The great majority of the unfortunate victims of such lesions are faced with a hopeless condition unless operated upon. If operated upon they are of necessity subjected to a procedure, the danger and difficulties of which increase in direct ratio to the duration of the complete obstruction. These patients have persistent deepening jaundice with accompanying symptoms of anorexia, loss of weight and strength and often unendurable pruritus. If the obstruction is of long standing their blood clotting time is prolonged, they have a narrowing margin of hepatic and renal efficiency and are altogether bad risks and yet as much in need of surgery as any group of abdominal cases.

These patients present three main types of lesions causing the obstruction. In the order of their frequency they may be grouped as follows:

1. New growths of the pancreas, common or hepatic ducts.
2. Chronic inflammatory lesions of the pancreas.
3. Stenosis of the ducts following trauma or inflammation.

For the side-tracking of the bile several methods have been used and in individual cases prove successful. But it should be strongly emphasized that the rare successes and not the many failures appear in the literature and the high risk and small chance of success are not sufficiently emphasized in the discussion of some of these methods. In general these may be grouped as follows:

1. The anastomosis between the gall-bladder and duodenum or stomach. Cholecystenterostomy is the easiest and most satisfactory of the procedures provided the cystic duct is patent and the obstruction is in the common duct below its junction with the cystic duct. Because of the relatively sterile duodenum and stomach, infection of the biliary tract is not so great a factor in these cases as when the stoma is made in the jejunum. For obstruction due to carcinoma of the pancreas or common duct the operation gives temporary relief. In one of our cases the patient survived two years, another three years with proven carcinoma of the common duct at the papilla. In the occasional case of chronic pancreatitis with complete obstruction, not associated with gall-stones, this operation is of special value. The stoma remains either as the permanent passage or until the inflammatory process in the head

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\* Read at the Meeting of the New York Surgical Society, April 27, 1927.

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of the pancreas subsides. It is in this type that biopsy is frequently the only means of differentiating between carcinoma of the head of the pancreas and chronic inflammation. In eight of the series here reported the diagnosis of carcinoma, from the history of gradually increasing painless jaundice, a palpable gall-bladder and the finding of a hard nodular head of the pancreas at operation, seemed certain. In three of these a section showed chronic pancreatitis. In the other five where section was not obtained a remarkable improvement with freedom from jaundice for periods of five months to two years made the diagnosis of carcinoma very questionable. In two of patients, autopsy at the end of two and three years proved the lesion to be carcinoma of the common duct. In the other three the diagnosis was never established though they died of pancreatic insufficiency.

Courvoissier's Law does not necessarily mean carcinoma and I believe these patients should be explored, section removed from the mass, if possible, for diagnosis and prognosis, and a cholecystenterostomy done for the relief it gives these patients even though it be temporary. From our experience common duct carcinoma is a less malignant lesion than carcinoma of the pancreas. The results as reported in other clinics:

*For Carcinoma.*—Kehr in a series of 71 patients with carcinoma of the pancreas in which he did the palliative cholecystenterostomy, and reported 10 of them alive after operation. It is not stated however that these were all proven cases by biopsy or autopsy. Guleke reports one of his cases died 2½ years after the operation.

*For Chronic Pancreatitis.*—Mayo-Robson reports a remarkable series of 102 cases of cholecystenterostomy for chronic pancreatitis with an operative mortality of only 3.9 per cent.

Kehr reported 8 deaths in 69 cases or 11.6 per cent. Unfortunately the late results are not given.

Guleke reports one case after two years in which a barium meal showed barium passing through the stoma into the gall-badder, through the cystic and common ducts back to the duodenum, proving the subsidence of obstruction in the head of the pancreas.

2. The second method to be considered is some form of anastomosis between the common or hepatic duct and the upper gastrointestinal tract, either by suture or by means of a tube connecting the duct with the intestinal tract. Choledoch- or hepatico-enterostomy or duct reconstruction is to be employed where the gall-bladder is absent or where the obstruction is above the level of the cystic duct. The lesions requiring these desperate procedures are most frequently the duct stenoses, following cholecystectomy, the result of inadvertant injury to the duct by the surgeon or of a choledochitis. Not all of these injuries are the result of careless or unintelligent surgery. The anomalous arrangement of the cystic or hepatic ducts may simulate the normal anatomy and the common or hepatic duct may be injured or severed under the eye of the most skilled surgeon. I well remember such an occurrence in the clinic of one of the ablest surgeons of this country. In fact the common

duct was severed a few minutes after he had warned his medical students of the dangers of such an accident. He proved himself worthy of his reputation as a great surgeon by recognizing the injury immediately, acknowledging it frankly and openly, and promptly repairing it with faultless technic.

Unfortunately the majority of these stenoses are the result of unrecognized injury to the ducts by the relatively inexperienced surgeon. Failure to define the cystic duct as a definite structure joining the neck of the gall-bladder with the common duct, injudicious application of a curved clamp with the tips pointing toward the common hepatic duct instead of toward the gall-bladder, too great traction on the gall-bladder with coning of the common duct and insufficient cystic duct stump, the hasty and blind application of a hæmostat to catch a spurting cystic artery in the gastro-hepatic omentum, injudicious application of the cautery to the cystic duct, failure to recognize an anomalous arrangement of the duct system, these are the inadvertant but not always excusable causes of subsequent stenosis.

There has been considerable discussion in regard to the dilatation of the cystic duct stump and recently Sweet has maintained that gall-stones are formed in the cystic duct. Notwithstanding the blame placed upon the cystic duct, it seems to the writer far more dangerous to attempt to remove all of the cystic duct because of the subsequent stricture and damage to the common duct that might ensue, than to leave a portion of the cystic duct as has been done in the past in the old cholecystectomy. The stump of the cystic duct, half a centimetre in length is far safer than an attempt to remove all of the duct.

If the injury is recognized and immediately repaired the end-to-end anastomosis is usually easy and stenosis seldom occurs. If after removing the gall-bladder, bile appears in the region of the gastro-hepatic omentum, injury to the common duct should always be suspected and should be ruled out before closing the abdomen. The cystic duct stump of the gall-bladder should be inspected to make sure it has the normal arrangement. I believe that if any anomalous vessel or duct is noted it is essential to remove the gall-bladder from the fundus down to the duct in order to avoid injury to abnormal ducts. I also believe that with the œdematous acute gall-bladders, with the accompanying œdema of the cystic duct and gastro-hepatic omentum, injury to the ducts is less liable to occur if the gall-bladder is removed from fundus to duct.

There are a certain number of acute cholecystitis cases associated with cholelithiasis. If in the removal of these gall-bladders the gastro-hepatic omentum is dissected or unduly traumatized, stenosis of the common duct is more liable to occur as a late complication or even a sequel. I look upon these cases as among the relatively few requiring cholecystostomy. Certainly drainage tubes along side and in contact with the cystic duct stump are to be avoided. Tube pressure on the gastro-hepatic omentum favors subsequent stenosis.

The appearance of jaundice within 48 hours after a cholecystectomy, with or without a later establishment of a biliary fistula is the unwelcome but warning sign of common or hepatic duct injury. Especially is this true



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if at time of operation there was no evidence of common duct stone, and very evidently if no stones were present or only a single cholesterol stone was removed with the gall-bladder. In these cases if the patient's condition permits, not more than ten days should elapse before exploring the patient for the cause and repair of the fistula.

It is the procrastination of the surgeon and patient that brings these cases to other surgeons after periods of weeks and months for the late repair of the duct injury. Too frequently they come after one or more attempts at repair have been unsuccessful. It is self-evident that the longer the duration of the jaundice and if more than one attempt has been made to repair the duct, the greater the danger to the patient, the more difficult the operation and the less chance of a permanently successful result. These patients have a prolonged clotting time that responds poorly to the usual measures, but calcium in the form of chloride or lactate given intravenously is essential as a pre- and post-operative measure. In 1918, the writer reported the successful use of calcium lactate intravenously and we have since used it with excellent results. We give it intravenously in a 0.2-0.5 per cent. solution in 5-10 per cent. glucose up to .6 gram amounts 12 and 6 hours before operation. Because of the narrow margin of liver and kidney efficiency glucose and fluids by clysis are essential as a pre-operative measure. Blood transfusion is necessary in some of these patients both before and after operation. Digitalis, given as the tincture in 8-10 c.c. in saline by rectum the night before has steadied the heart action in our cases and helped to tide over a stormy post-operative course in two cases with myocardial damage.

If a biliary fistula is not present some form of anastomosis between the common or hepatic duct and the duodenum is the method of choice. I am sure that if a suture anastomosis can be made between distended duct and duodenum without the insertion of a tube, the result will be more permanently satisfactory. If a tube has to be used where only a partial suture repair is feasible it should not be sutured into the line of anastomosis if the tube projects for any distance into the duodenum. In one of my cases, in which I was able to do a satisfactory suture anastomosis between duodenum and junction of right and left hepatic duct the peristalsis of duodenum pulled on the tube that had been sutured into the line of anastomosis and tore the anastomosis on the third day after operation.

The attempts to reconstruct a passage between hepaticus and duodenum by means of a rubber tube covered with omentum are seldom permanently satisfactory. A few cases have been reported free from jaundice for periods of over a year, but they are exceedingly rare and the failures are not reported. The fundamental difficulty in these attempts to bridge the gap between duct and intestine with a peritonealized tube is that the irritating contaminated bile causes a round cell infiltration of the wall of the tube with subsequent connective tissue replacement and scar tissue contracture. Horsley has discussed this principle in detail based upon his animal experiments in everted veins as a means of bridging bile duct defects. The same principle



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It is with the desire to stimulate the publication of all the cases in an individual clinic that the following report is made. It is not until the failures as well as the successes of several clinics are published that the hazards and difficulties of such procedures will be realized in proportion to the successes.

### *Side-Tracking Operations at Presbyterian Hospital in Twelve Year Period*

Total number .....	35
Cases with Carcinoma .....	21
Carcinoma of the Pancreas .....	16
Cholecystoduodenostomy .....	8      1 patient lived 25 months.
Cholecystogastrostomy .....	6      1 patient lived 7 months.
Carcinoma of Common Duct .....	4
Cholecystoduodenostomy .....	3      } 1 patient lived 36 months.
Choledochoduodenostomy .....	1      } 1 patient lived 24 months.
Carcinoma of Gall-bladder .....	1
Transduodenal Choledochostomy .....	1
Benign Lesions .....	14
Chronic Pancreatitis .....	6
Cholecystoduodenostomy .....	4      } 1 patient lived 19 months.
Cholecystogastrostomy .....	2      } 1 alive 5 months.
Stenosis of Common Duct .....	6      } 1 living 12 months.
Choledochoduodenostomy .....	3      } 1 last heard from 27 months
Implantation of fistulous tract into stomach .....	3      } post-operative.
Atypical Cirrhosis .....	1
Cholecystogastrostomy .....	1
Cyst of Hepatic Duct .....	1
Choledochoduodenostomy .....	1
Of the 21 Carcinoma cases—None are now living.	
Of the 14 Benign cases—4 are living and well.	

### CASE REPORTS

CASE I.—G. M., age thirty-one, male. Patient admitted to P. H., April 5, 1924, with history of loss of appetite and strength for two years. He became jaundiced and had clay-colored stools. Following an osteopathic treatment during which he was pummelled in the region of the liver, he had a severe sharp pain in the right upper quadrant, going to the back. He vomited two or three times. In bed a week.

One month before admission he began to have recurrence of pain in the right upper quadrant associated with light-colored stools. No nausea or vomiting. Two days before admission he had a severe attack of pain in the right upper quadrant radiating to back.

On admission he was slightly jaundiced, uncomfortable with pain and there was considerable spasm in the epigastrium and the right upper quadrant. Temperature 99. Pulse relatively normal. Respiration 24. White blood cells 13,500. Polymorphonuclears 76 per cent. Trace of bile in the urine.

*Diagnosis.*—"Acute cholecystitis."

*Operation.*—Cholecystectomy.

Gall-bladder markedly distended, oedematous with fibrin on its surface. It was aspirated and removed. No stones felt in bladder or ducts. Cigarette drain to Morrison's pouch.

*Pathological Report.*—Gall-bladder with wall 6-7 mm. thick. No calculi. Mucosa destroyed, its place being taken by fibrin. Extensive blood extravasation in the submucosa with some œdema and leucocytic infiltration. Submucosa enormously thickened by œdema and fibroblast infiltration.

*Course* complicated by post-operative pneumonia. Third day post-operative, up to which time patient had been jaundiced, the dressing was soaked with bile. After this the biliary fistula persisted and the stool was repeatedly negative for bile, until the patient was given his own bile by mouth which he took for a period of five weeks.

Eighty-six days post-operative a second operation was performed by Doctor St. John at which the great omentum and transverse colon, liver, duodenum and stomach were found to be adherent. Distal portion of the biliary sinus was dissected, including the surrounding skin for about 1 cm. in all directions, and implanted into the prepyloric segment. Wound closed without drainage.

*Post-operative Course* uncomplicated. Patient discharged twenty-six days post-operative, bile having been present consistently in the stool after operation, and there having been no jaundice.

One year post-operative patient is symptom-free. Has gained sixty pounds.

Twenty-one months after second operation, patient is symptom-free, appetite excellent. Has not lost a day's work in sixteen months.

CASE II.—E. H., age fifty-four, male. *Chief Complaint.*—Jaundice, pruritus, diarrhœa. Patient was admitted to the Medical Ward with four weeks' history of deepening jaundice, diarrhœa, loss of weight. During this time he had had no pain. Diarrhœa had varied from six to sixteen stools a day, he had lost fourteen pounds in ten days.

*Past.*—He had had no previous similar trouble. Typhoid at 20. No history of biliary colic or digestive disturbances. Occasional alcoholic excesses.

*Physical Examination.*—Patient was thin, jaundiced. Blood pressure 85/45. Liver edge flat, firm, not tender, 9 cm. below xiphoid. No masses felt. Wassermann negative.

*Diagnosis.*—Chronic pancreatitis. Cholecystogastrostomy.

*Operation.*—Cholecystogastrostomy. Anæsthesia local. .5 novocaine.

*Findings.*—The findings were remarkable. (1) Liver was enlarged to level of the umbilicus and had the appearance of a biliary cirrhosis.

(2) The gall-bladder was greatly distended, filled with a "white" thin bile which continued to pour out into the gall-bladder when aspirating cannula was inserted, from the hepatic ducts, *i.e.*, cystic duct was patent.

(3) No stones were found in either gall-bladder or common duct.

(4) The pancreas was hard, irregularly indurated, nodular, both in head and body.

(5) The duodenum was anomalous in that it lay retroperitoneal and to the median side of pars pylorica so that sufficient exposure, even of the first and second positions could not be obtained or exposed for a cholecystoduodenostomy.

(6) There was a very marked hypermotility of the stomach, especially pars pylorica—patient was under local anæsthesia throughout.

*Procedure.*—Arch and incisional anæsthesia with .5 per cent. novocaine giving excellent anæsthesia and good exposure. On noting the above findings diagnosis of carcinoma of the pancreas was made. A section from the pancreas was removed for diagnosis. Trochar and cannula inserted in median aspect for gall-bladder white bile aspirated. Because of duodenal anomaly a cholecystogastrostomy was decided upon, and was done with chromic, side of gall-bladder to side of pars pylorica, sero-serous suture followed by over and over running suture of all coats of the two stomata. Opening .5 cm. resulted from the anastomosis which was entirely satisfactory when completed. Closure: Peritoneum and post-rectus sheath continuous intersilk. Anterior rectus sheath, continuous intersilk. Subcutaneous tissue and skin, four silk sutures on nail buttons. Skin, continuous dermal. No drain to peritoneum. Short goitre tube to subcutaneous tissue.

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*Pathological Report.*—Pancreas—Chronic pancreatitis. Cultures of gall-bladder and bile—Staphylococcus Albus.

First day post-operative—blood pressure 116/60.

Second day post-operative—stool for bile negative.

Third day post-operative—stool for bile++.

Fourth day post-operative—stool for bile++++.

Seventh day post-operative—jaundice decreasing, appetite returning, diarrhoea cleared.

Discharged seventeenth day.

Follow up fourteen months after operation, no recurrence of jaundice or of any other symptoms.

CASE III.—M. S., age fifty-four, male. *Chief Complaint.*—Persistent jaundice. For several years has had what he calls "dyspepsia"—epigastric distress, at times increasing to a severe pain radiating to the back. With these attacks he would have nausea and distaste for food. Aside from this there is no definite history of any typical gastric or biliary syndrome. No previous history of jaundice. Habits temperate.

Three weeks before admission he had an unusually severe attack of epigastric pain, going through into his back, with nausea and anorexia. Soon after this he began to develop jaundice which has continued increasing, although stools have varied in color. For the last two weeks before admission he had chilly sensations and real chills, with variable rises in temperature. He was examined two weeks before admission, when he showed light jaundice, tenderness in epigastrium, no palpable mass or gall-bladder in the right upper quadrant. The liver was enlarged. The differential diagnosis was thought to be between common duct stone and carcinoma of the pancreas. Because of deepening jaundice and recurring chills operation was advised and accepted.

On admission, he was deeply jaundiced. Liver enlarged 5 cm. below costal margin, no palpable mass suggesting gall-bladder. Tenderness vague in upper abdomen.

*Operation.*—Cholecystoduodenostomy for common duct obstruction due to pancreatitis.

*Findings.*—Contrary to expectation no stones were found in the common duct or in the gall-bladder. The gall-bladder was markedly dilated. The liver was somewhat enlarged, overlapping the enlarged gall-bladder. The seat of the obstruction was found to be in the head of the pancreas where hard nodular mass was discovered, apparently closing the common duct. This in the gross appeared to be carcinoma. A section was taken from the hardest part of the mass, fairly good sized, making it possible to provide ample material for pathological examination. The absence of stones in the gall-bladder was a corroboratory evidence of the absence of stone finding in the common duct. Because of the lesion in the pancreas and the dilation of the gall-bladder, short circuiting operation was decided upon and the fundus of the gall-bladder was sutured to the outer side of the second portion of the duodenum as follows:

*Procedure.*—An opening a centimetre long was cut in both the gall-bladder and the duodenum after the serous surfaces of the two viscera had been sutured in a semi-circle. The cut edges of the two stoma were then united by means of a through and through suture of all the guts. The sero-serous suture was then resumed to the point of beginning. The abdomen was then closed as follows without drainage: Peritoneum and posterior rectus sheath, continuous chromic interrupted twice, anterior rectus sheath, continuous chromic, subcutaneous tissue and skin and anterior rectus sheath, silk on pearl buttons. Skin, continuous dermal.

*Post-operative Course.*—For several days he was asthenic. Blood urea rose to 1.23 gms./L. He had anorexia and vomiting, jaundice cleared slowly. Blood-pressure dropped from 120/80 on second day to 98/60 on twelfth. Discharge twenty-second day. Weight 128 pounds.

One month follow-up: Jaundice cleared. Feeling well except for some distress if he eats too much or certain foods such as fats and rich food.

## ALLEN O. WHIPPLE

Four months' follow-up: Has had no recurrence of jaundice. Has gained eighteen pounds in weight. Is feeling well except for some distress after eating fats or highly seasoned foods.

Seven months' follow-up: One month after last follow-up patient developed signs of pyloric stenosis, not relieved by lavage, and requiring a gastro-enterostomy for a stenosis of the duodenum, caused by the angulation as a result of contraction of the gall-bladder. Examination of the pancreas at this time revealed a hard mass at the head of the pancreas, section from which proved to be a carcinoma. The patient at the last report was losing ground in weight and strength, although he had had no recurrence of jaundice or of gastric obstruction.

# METASTATIC CARCINOMA IN THE URETER\*

REPORT OF ADDITIONAL CASES

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PRIMARY tumors in the pelvic viscera frequently metastasize into the lymph-nodes along the iliac vessels and abdominal aorta, in a large number of cases metastatic nodules are found in the bones, lungs or liver as described by Langstaff,<sup>1</sup> Tanchau,<sup>2</sup> Gross,<sup>3</sup> Adams,<sup>4</sup> Thompson,<sup>5</sup> Von Recklinghausen,<sup>6</sup> Cone,<sup>7</sup> Blumer,<sup>8</sup> Bumpus,<sup>9</sup> Kaufmann,<sup>10</sup> Young,<sup>11</sup> and others.

Since the lymphatics of the ureters communicate with those of the bladder, it is surprising that so few reports on metastatic carcinoma in the ureter and kidney pelvis are to be found in the literature.

Garceau,<sup>12</sup> in 1909, was able to collect from the literature 13 cases of metastatic carcinoma in the ureter due to extension by continuity.

Giordano and Bumpus,<sup>13</sup> in 1922, reported a case of carcinoma of the prostate metastasizing to the left ureter and renal pelvis, which showed no evidence of invasion of the lymphatics in the ureter, and were able to demonstrate cancer cells in the blood-vessels of the lungs and in a metastatic renal infarct.

Thomas and Regnier,<sup>14</sup> in 1924, reported a case of carcinoma of the bladder with metastases to lymph-glands, liver, psoas muscle and right ureter, without indicating how it was transmitted.

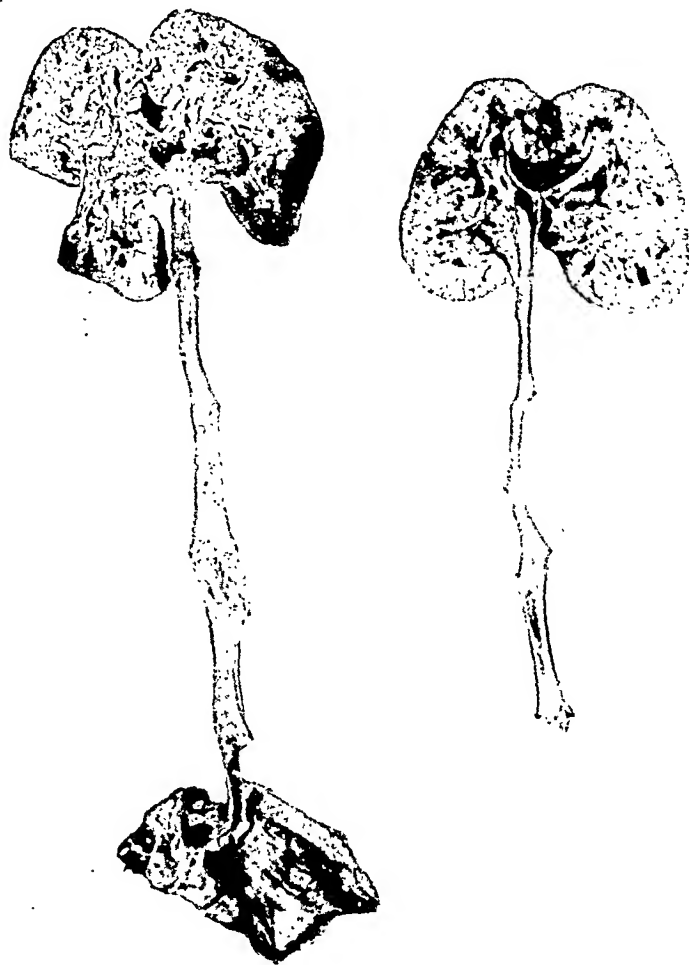


FIG. 1.—Case I. Carcinoma of the prostate with metastasis to right ureter; ureteral dilatation, bilateral; ureteritis, bilateral.

\* Read before the Wisconsin Urological Society, March 19, 1927.

Cullen<sup>15</sup> has shown cancer of the cervix ulcerating through the lower end of the ureter, but makes no mention of metastatic nodules in the ureteral wall, the result of lymphatic metastasis.

Ewing<sup>16</sup> describes papillary tumors of the bladder extending into the lumen of the ureter or invading from the vesical wall, and primary tumors of the kidney pelvis extending down the ureter. In prostatic cancer Ewing states that the ureters are invaded from the vesical wall as in bladder



FIG. 2.—Case I. Photomicrograph of right ureter, 20 cm. above bladder, showing tumor cells in peri-vascular lymphatic.

carcinoma, or occluded by nodules at the orifice, or compressed by enlarged lymph-nodes.

Herger and Schreiner,<sup>17</sup> more recently in an analysis of thirty-two autopsies on patients dying from carcinoma of the cervix, found twenty-one cases showing gross pathological changes in the urinary apparatus—viz.: stricture of left ureter with accompanying hydronephrosis, 4; stricture of right ureter with accompanying hydronephrosis, 3; ureteral stricture, bilateral with accompanying hydronephrosis, 10; pyonephrosis, 1; caseous kidney, 1; infiltration into bladder, with no hydronephrosis, 2; 16 of the cases showing hydronephrosis were accompanied by marked infiltration into the bladder. They concluded that the ureteral strictures are the result

of pressure on the ureter from invasion of the broad ligament or bladder wall, which possibly may be made worse as a result of fibrosis in the healing of these lesions, but make no mention of metastases into the ureter.

Young<sup>18</sup> states that metastasis to the wall of the ureter may occur, usually the lower third, causing obstruction with hydro-ureter and hydronephrosis. The route in such cases may be lymphatic and records having seen two cases of ureteral metastases from prostatic carcinoma.

Bumpus<sup>19</sup> in a clinical study of one thousand cases of carcinoma of the prostate found 243 cases with demonstrable metastases. In 44 per cent. it had affected the lymphatics.

Since the writer<sup>20</sup> first demonstrated cancer cells in the perivascular lymphatics of the ureter, secondary to primary carcinoma of the bladder, prostate and cervix uteri two additional cases have been found at autopsy.



# METASTATIC CARCINOMA IN THE URETER

## CASE REPORTS

CASE I.—J. S., white, male, age seventy-three years. Admitted to University Hospital, December 30, 1924, with acute retention of urine and died June 22, 1925.

*Clinical Diagnosis.*—Carcinoma of the prostate with metastases to the third, fourth, and fifth lumbar vertebra; uræmic coma. Terminal lobular pneumonia. Genito-urinary organs. (Fig. 1.)

*Prostate.*—The prostate is very firm and nodular on section, there are numerous irregular areas of a grayish-yellow color. In the lower portion of the tumor mass there is a cavity formation, the wall of which is of a grayish-black color, having the appearance of a radium burn. The outline between the prostate and seminal vesicles is very indistinct due to direct extension of the tumor. Lymph-nodes along the internal and common iliac arteries and abdominal aorta show metastatic deposits.

*Bladder.*—The bladder wall varies from 3 to 6 mm. in thickness, mucosa is of a dark red color, covered with yellowish exudate in areas. Ureteral orifices are moderately dilated 3 mm.

*Ureters.*—The ureters are dilated from the bladder wall to the uretero-pelvic junction varying in diameter from 10 to 20 mm., with the greatest diameter above the pelvic brim. On section

their walls measure 2 mm. in thickness with the mucosa varying from bright red to dark red in color, in areas a yellowish exudate is seen on the surface of the mucosa.

*Kidneys.*—The pelves, major and minor calyces are moderately dilated with their mucosa of a dark red color.

The capsules strip off with resistance, leaving an irregular dark reddish surface with a few small round yellowish areas which contain a purulent exudate.

The architecture is poorly preserved.

*Anatomical Diagnosis.*—Adenocarcinoma of the prostate with metastases to the lymph-nodes along the iliac arteries and abdominal aorta; lumbar vertebra; seminal vesicles; bladder wall; right ureter; dilatation of ureter, bilateral; hydronephrosis, bilateral; cystitis; ureteritis, bilateral; pyelitis, bilateral; pyonephrosis, bilateral; duodenal ulcers, etc.

*Microscopical Notes.*—*Prostate:* Sections from each lobe show the muscle fibres and connective-tissue fibres to be well stained. The glandular acini show their lining epithelial cells to be very well stained, most of which have hyperchromatic nuclei, a moderate number show mitotic cell division. These cells are seen breaking away from their basement membrane and infiltrating through the stroma. There is a definite reduplication of prostatic glandular acini arranged in a disorderly fashion. The blood-vessels show thickening of the tunica intima.

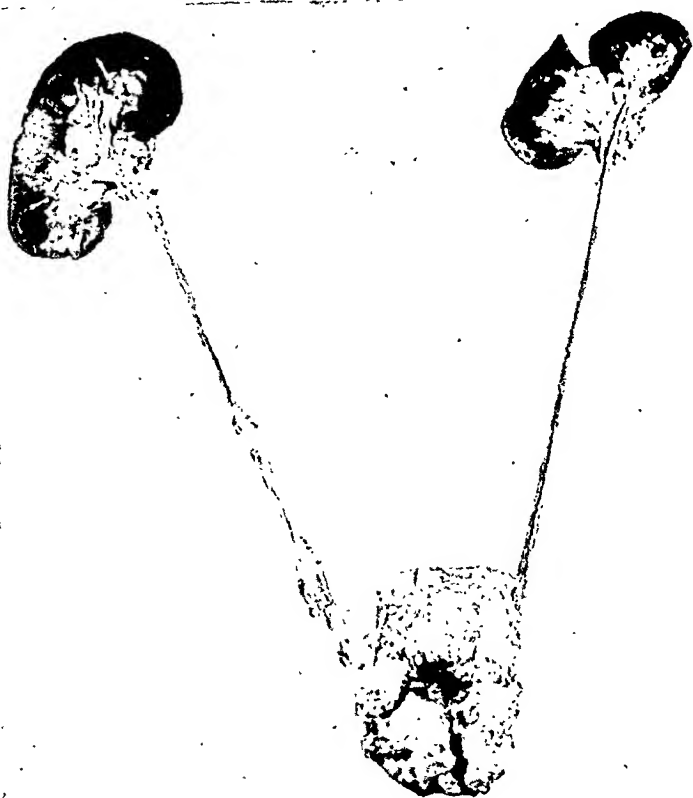


FIG. 3.—Case II. Carcinoma of prostate with metastases to the bladder, seminal vesicles, right ureter, right kidney pelvis, cystitis.

*Seminal Vesicles.*—Sections show a definite infiltration of epithelial cells which have a hyperchromatic nuclei and a clear cytoplasm, a few showing mitotic cell division. In areas they are arranged as glandular acini giving the same appearance as those seen in the prostate.

*Bladder.*—Sections from base and lateral walls show an infiltration through the muscular layer and submucosa of epithelial cells, columnar or cuboidal in shape in areas, a large number are undifferentiated in appearance, with hyperchromatic nuclei and a clear cytoplasm, mitotic cell division is visible in areas. These cells are seen breaking away from their basement membrane in various areas.

*Ureters.*—Right (Fig. 2). (Section from 10 cm. up and 20 cm. up.) The serous surface shows the serosa to be fairly well stained. Immediately beneath the serous cells is seen a moderate infiltration of mononuclear wandering cells and large round cells, an occasional plasma cell is noted. In the inner two-thirds of the muscular layer an infiltration of epithelial cells undifferentiated in type with hyperchromatic nuclei and a clear cytoplasm. A few show mitotic cell division. In areas they are arranged as small glandular acini. The tumor cells are visible in the perivascular lymphatics. The tunica propria shows a moderate infiltration of mononuclear wandering cells with an occasional polymorphonuclear leucocyte. Mucosa is absent for the most part, in one area the transitional epithelial cells are seen well preserved.

*Left.*—In the muscular layer there is a definite infiltration of mononuclear wandering cells and small round cells with a few polymorphonuclear leucocytes, they are more abundant in

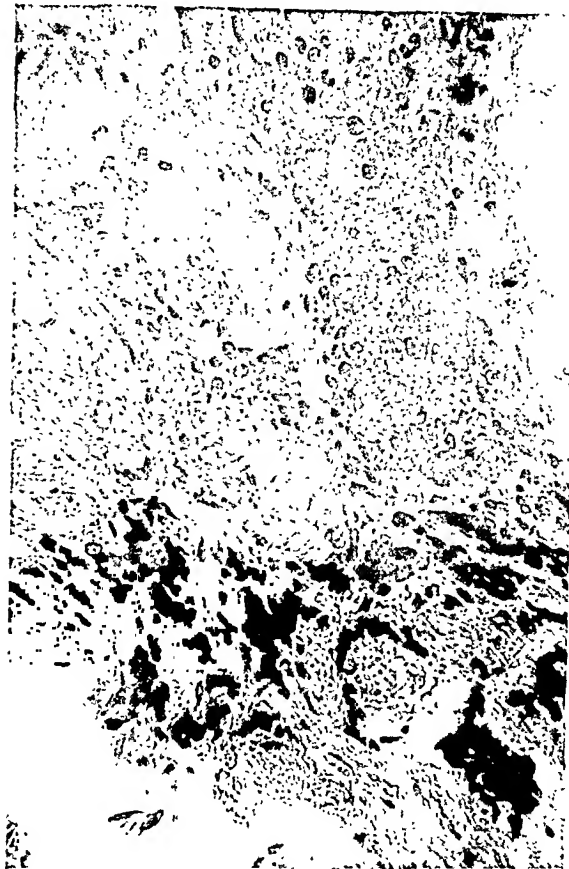


FIG. 4.—Case II. Photomicrograph right ureter 15 cm. below uretero-pelvic junction, showing tumor cells in lymphatics.

inner half of the muscular layer and tunica propria. Mucosa shows the transitional epithelial cells poorly stained with fibrin and poorly stained leucocytes within the lumen. Blood-vessels are filled with red blood-cells with the perivascular lymphatics visible.

CASE II.—R. McN., white, male, age seventy-five years. Admitted to University Hospital, September 25, 1925, with acute retention of urine and died September 30, 1925.

*Clinical Diagnosis.*—Carcinoma of the prostate; myocardial hypertrophy and insufficiency; paralysis agitans, etc. Genito-urinary organs. (Fig. 3.)

*Prostate.*—The prostate is enlarged, firm and nodular, on section numerous irregular yellowish-gray nodules are seen. From this tumor mass in the prostate, metastasis can be seen by continuity, infiltrating into the base of the bladder, seminal vesicles and lymph-nodes.

*Bladder.*—The bladder wall is markedly thickened, measuring from 8 to 14 mm. in thickness. In the muscular wall at the base, there are irregular yellowish-gray lines. Mucosa is dark red in color, ureteral orifices gaping 3 mm. in diameter

*Seminal Vesicles.*—Are enlarged, firm and nodular, on section numerous irregular

## METASTATIC CARCINOMA IN THE URETER

yellowish-gray nodules are seen. There is no definite line of separation between the bladder and seminal vesicles.

*Ureters.*—*Right:* There is a moderate dilatation of the lower 15 cm. varying from 8 to 10 mm. in diameter. On section the wall measures 2 mm. in thickness with the mucosa of a dark red color. On palpation several small nodules can be felt 6 cm. below the ureteropelvic junction.

*Left.*—The diameter varies from 2 to 7 mm. On section the wall measures 1 to 2 mm. in thickness with the mucosa showing several areas of a dark red color.

*Kidneys.*—*Right kidney,* 10.5 by 6 by 3 cm. *Left kidney,* 10 by 5.4 by 4 cm.

The capsules strip off with marked resistance, leaving a finely granular reddish surface. On section the kidneys are seen to be contracted, with the architecture poorly preserved. The blood-vessels stand out prominently in the cortical portion. The mucosa of the pelves and calyces is dark red in color.

*Anatomical Diagnosis.*—Carcinoma of the prostate with metastases to the bladder, seminal vesicles, right ureter, right kidney pelvis, lymph-nodes along the internal iliac arteries, abdominal and thoracic aorta, and lungs; cystitis; hypertrophy of bladder wall; chronic diffuse nephritis, arteriosclerotic type, etc.

*Microscopical Notes.*—*Prostate:* Sections from each lobe show the muscle fibres and the connective-tissue cells to be poorly stained. There is a marked glandular hyperplasia. There are many new-formed glandular acini lined by epithelial cells which are for the most part undifferentiated in type, with clear cytoplasm and hyperchromatic nuclei. A large number of these cells are seen breaking away from their basement membrane, and infiltrating in a disorderly fashion between the connective-tissue cells and the muscle fibres.

*Bladder.*—Section taken from the trigon shows a definite infiltration through the muscular layer of epithelial cells embryonic in type, mitotic cell division being visible. In the submucosa a moderate number of mononuclear wandering cells and polymorphonuclear leucocytes are seen. The mucosa is poorly stained throughout. Blood-vessels show a marked thickening of the tunica intima.

*Seminal Vesicles.*—Sections show the same type of tumor cells arranged as glandular acini.

*Urter.*—*Right.*—(Fig. 5.) Six cm. below uretero-pelvic junction. The outer half of the muscular layer shows a definite infiltration of epithelial cells of an undifferentiated type with clear cytoplasm and hyperchromatic nuclei. A few of these cells are undergoing mitotic cell division. The perivascular lymphatics show their sinuses filled with tumor cells. In several areas the perivascular lymphatics are replaced by epithelial cells arranged as glandular acini. The tunica propria is poorly stained, with a moderate number of small round cells, mononuclear wandering cells, and polymorphonuclear leucocytes beneath the mucosa. Mucosa—shows the transitional epithelial cells intact on their basement membrane, a few of which are poorly stained.



FIG. 5.—Case II. Photomicrograph right ureter, 6 cm. below uretero-pelvic junction, peri-vascular lymphatics are replaced by epithelial cells arranged as glandular acini.

*Kidney Pelvis.—Right.*—(Fig. 6.) The muscular layer shows the muscle fibres to be poorly stained. There is a marked increase of fibrous connective tissue separating the muscle fibres. The blood-vessels show a perivascular infiltration of epithelial cells with clear cytoplasm and a hyperchromatic nuclei, a few of which show mitotic cell division. The tunica propria shows a moderate infiltration of small round cells and mononuclear wandering cells. Mucosa shows the epithelial cells well preserved and intact on their basement membrane.

*Discussion.*—"The lymphatics of the ureter are more numerous in the muscular coats and adventitia than in the mucosa and sub-mucosa. They accompany the arteries and drain in three directions, the lower portion downward in the direction of the bladder, the pelvic and abdominal portion mesially into the pelvic and lumbar lymph-glands, the upper portion in the direction of the renal lymphatics." Kelly and Burnam.<sup>21</sup>

In 1923, Arthur Robinson<sup>22</sup> states that little is known of the lymph-vessels of the ureter except that those of its lower extremity anastomose with the bladder and suggests that the vessels pass to the nearest lymph-glands.

While the lymphatic system is, without doubt, the earliest and most frequent site of metastatic lesions in carcinoma of the

FIG. 6.—Case II. Photomicrograph right kidney pelvis, showing tumor cells in the peri-vascular lymphatics.

prostate,<sup>19</sup> it would seem that the drainage of the lymph downward, in the lower portion, is the explanation for the rarity of metastases to the ureters from prostate or other pelvic viscera.

Giordano and Bumpus<sup>13</sup> were the first to demonstrate carcinoma of the prostate metastasizing to the renal pelvis and are of the opinion that it is carried through the blood stream.

In Case II previously reported<sup>20</sup> and Case II of this report the cancer cells were carried through the lymphatics to the renal pelvis.

Herger and Schreiner,<sup>17</sup> in 1926, report strictured ureters, hydro-nephrosis and pyonephrosis occurring in cancer of the cervix, without a microscopical description. These were probably inflammatory in origin as described by Carson in 1925.<sup>20</sup>

# METASTATIC CARCINOMA IN THE URETER.

## CONCLUSIONS

(1) Two cases of primary carcinoma of the prostate extending to the ureters by lymphatics are reported.

(2) A third case of carcinoma of the prostate metastasized to the renal pelvis is reported.

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# ENLARGEMENT OF THE PROSTATE GLAND WITH CHARACTERISTICS RESEMBLING HODGKINS' DISEASE\*

MALIGNANT GRANULOMA

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THIS report concerns a case of complete retention of urine due to a gradually increasing enlargement of the prostate gland in a young man aged thirty-two years.

The case presents a number of unusual features. Complete retention of urine due to enlargement of the prostate gland is very rare indeed in a man of this age, excepting when the increase in size is due to some acute infection of the gland usually associated with abscess formation.

A search of the literature has failed to reveal any reference to a condition simulating that found in this case. While a neoplasm might have been suspected we have not seen a description of any tumor of the prostate at this particular age. Sarcoma of the prostate usually occurs much earlier and carcinoma and benign enlargements occur later in life.

While we have reviewed the literature of malignant granuloma, it will suffice to state here that the Hodgkin's granuloma so-called, shows when fully developed a highly characteristic histological picture which enables one to make a more or less positive diagnosis. In many instances, however, this picture is not fully developed and the histological diagnosis then becomes increasingly less certain, and it may be added that the lesions of the prostate which we propose to consider in this paper belongs to this latter group as is evidenced by the report rendered on the case by the pathologist. While there is therefore some uncertainty concerning the nature of the lesions found, the case seems worthy of record because it presents certain features simulating Hodgkin's disease.

The blood picture in Hodgkin's disease as stated by F. C. Wood<sup>1</sup> does not yield as much information as the clinical features of the disease. Frequently we get a moderate anæmia of the chloritic type, that is, with a relatively high number of red cells and a low hæmoglobin index. Poikilocytosis and degenerative changes in the red cells are not marked. The leucocytes are generally assumed to show no quantitative or qualitative changes, but it has been claimed by Pinkus<sup>2</sup> that all cases of pseudoleukæmia have a distinct relative lymphocytosis which enables this disease to be easily distin-

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\* Read before the New York Branch of the American Urological Association, March 23, 1927.

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guished from other conditions resembling Hodgkin's disease, especially from those cases from which tubercle bacilli have been found in the lymph-node of patients otherwise running a course perfectly typical of true Hodgkin's disease.

Wood<sup>1</sup> and Da Costa<sup>3</sup> state that a few cases show a relative lymphocytosis but these are in the minority. Ewing,<sup>4</sup> on the other hand, thinks that a relative or absolute lymphocytosis usually prevails.

Bunting<sup>5</sup> declares that an eosinophilia is so frequent and marked as to form an important diagnostic sign. Sabrazes Hippel<sup>6</sup> states that evidences of hemorrhagic tendency are frequently observed as minute hemorrhages in the skin, petechiæ or purpura hemorrhagica.

Ralleston,<sup>7</sup> Brammell,<sup>8</sup> believe that the disease occasionally exhibits prodromal symptoms such as itching or erythematous eruption of the skin which may precede other symptoms by months or years. This bears considerable relation to the subsequent cause of lymph-node

lesions, and may result in the definite and progressive cutaneous lesions of Hodgkin's disease. Gastro-intestinal disturbances may also be observed.

Our case presented a definite lymphocytosis, a moderate anæmia of the chlorotic type, an enlargement of the chain of inguinal lymph-nodes on each side, a loss of weight and strength and an impaired appetite and the general appearance of a tuberculous individual all associated with enlargement of the prostate, acute retention and urinary symptoms of only three months' duration. The case upon which this report is based presented the following history:

A single man, age thirty-two years, was admitted to the Medical Division of Dr. Lewis B. Conner on December 7, 1926, and transferred to the Urological Division December 11, 1926. He stated that his father died at the age of fifty-nine, from cancer of the liver. He was ill fifteen months. His mother died at the age of twenty-eight, from pulmonary tuberculosis. She was ill one and a half years. He has one brother and two sisters, all living and well. He denies lues and gonorrhœa by name and symptoms. He had mumps ten years ago, pneumonia fourteen years ago. Until four years ago he was a chronic drinker. Since that time has not touched liquor. About three months before admission to the hospital he developed a moderate frequency of urination by day and by night. As time progressed this condition grew worse and was associated with

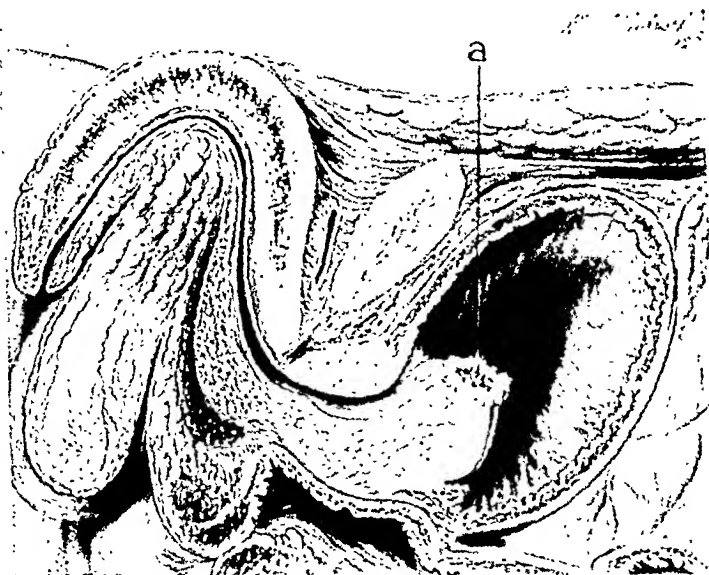


FIG. 1.—This picture is a sagittal view representing the enlargement of the prostate gland with marked intravesical intrusion. On its most prominent portion is represented the fungus-like appearance of that part whence a piece had been removed for diagnosis.

painful and difficult urination. He noticed no pus nor blood in his urine. His sexual powers were undisturbed. Three days before admission to the hospital he was unable to void except with utmost pain and difficulty. He finally developed acute retention and was brought to the hospital in an ambulance. His bladder was decompressed gradually by means of a retention catheter. He was fairly well nourished and seemed in moderately good health, although he stated that he had lost twenty pounds in weight during the past six months and during the past three months he had grown progressively weaker, but had not been confined to his bed. He had no cough. His bowels moved regularly. His appetite was somewhat impaired. He did not suffer from insomnia but grew dyspnoëic on slight exertion.

His general physical examination was negative except for moderate bilateral enlargement of the inguinal lymph-node and a small fibroma on the inner aspect of the left thigh. His liver and spleen were not palpable. Chest negative. The lower poles of both kidneys could be felt as well as the distended bladder. Rectal examination revealed slight hemorrhoids. Sphincter tone was good. The prostate was about twice the usual size; it was hard on the right side but did not have the board-like rigidity of carcinoma. The left side of the prostate seemed normal in consistency and not fixed in position by adhesions. The left seminal vesicle was palpable but not enlarged. The right was barely palpable.

Cystoscopy under caudal anaesthesia revealed a diffusely reddened vesical fundus. Ureteral orifices were not distinctly seen. The vesical orifice was most interesting in that it showed a tremendous intrusion of the sub-cervical group on its floor.

Blood urea nitrogen was 17 mgs. per 100 c.c.; blood sugar 0.112 per cent.; carbon dioxid combining power of the blood plasma 56 volumes per cent. The phenolsulphone-phthalein test showed a secretion of 60 per cent. in two hours at one examination and 75 per cent. at another. Blood Wassermann was negative on two occasions. Cultures from bladder urine showed—*B. Coli Communis* and *Staphylococcus Albus*.

Urine examination, reaction acid, specific gravity 1018, there was a trace of albumen, no sugar, no acetone.

Microscopic examination showed many red blood-cells, few white blood-cells, occasional epithelial cells, no crystals, no casts.

Complete blood count was made on two occasions as follows:

	12/8/26	1/9/27
Red cells .....	5,112,000	4,815,000
Hæmoglobin .....	93%	88%
Color index .....	0.91	0.92
White cells .....	8,600	7,400
Polymorphonuclear neutrophiles .....	54%	48%
Lymphocytes .....	38%	44%
Large mononuclears .....	6%	7%
(Transitionals)		
Eosinophiles .....	2%	3%
Blood-pressure on entrance to hospital.	114 systolic	62 diastolic

X-rays of the genito-urinary tract revealed both kidney shadows large in size and low in position. There was no shadow indicative of stone in the urinary tract.

The patient was subjected to a supra-pubic cystotomy under local anaesthesia. Examination of the interior of the bladder revealed a mass extending from the floor of the bladder neck about the size of a walnut which was rather firm in consistency. A specimen was taken from this tumor-like projection and sent to the laboratory for examination. (Fig. 1.) The bladder was drained by supra-pubic suction for a period of fourteen days, after which time the prostate was removed suprapubically under sacral and para-



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sacral and regional anæsthesia. It was interesting to note that this growth had greatly increased in size since the first operation. The site whence the original specimen had been removed had grown out in a very irregular manner so that it resembled a cauliflower. Malignancy was suspected. The prostate was removed completely except for one point on the left lateral aspect where it was densely adherent and had apparently infiltrated into the capsule of the prostate. The patient made an uneventful recovery and was discharged from the hospital fourteen days after prostatectomy with good urinary control and wound completely healed.

The prostate was examined by the Laboratory Division of the New York Hospital. The report is as follows:

The specimen consisted of several irregularly shaped pieces of tough tissue measuring from 1 to about 4 cm. in diameter. The cut surface appears yellowish-white, somewhat translucent, with opaque yellowish strands running through a whitish matrix. The gross picture is not that of a carcinoma nor does it resemble normal prostatic tissue.

The microscopic examination shows the picture of a chronic inflammatory process. The granulomatous new-formed tissue is rich in plasma cells and contains mononuclear giant-cells suggestive of the Sternberg type, and also eosinophilic leucocytes. While these features are suggestive of Hodgkins lymphogranuloma, the evidence available is not sufficient to make a diagnosis of the disease.

An inguinal lymph-node was removed and examined. Microscopic sections showed simple chronic lymphadenitis with no evidence of a granulomatous process like that seen in Hodgkin's lymphogranulomatosis.

The small tumor on the inner aspect of the left side showed on microscopic sections the picture of a fibroma durum, covered by stratified squamous epithelium.



FIG. 2.—Photomicrograph of a section cut through the enlarged prostate gland. Microscopic examination of this section shows the picture of a chronic inflammatory process. The granulomatous new formed tissue is rich in plasma cells and contains mononuclear giant cells suggestive of the Sternberg type. There are also eosinophilic leucocytes.

### SUMMARY OF FINDINGS

It is unusual to find a complete retention of urine in a man, age thirty-two years, due to a solid tumefaction of the prostate gland.

The gradual onset of the symptoms exhibited by the patient is similar to those described by most cases of adenomatous enlargements of the prostate in old men. The usual frequent and painful urination culminated in complete retention of urine rather more rapidly than most cases of adenoma.

There was a rapid increase in the size of the intrusion in the two-week interval between the supra-pubic cystotomy at which time a piece of tissue was removed from the tumor for diagnosis and the actual removal of the mass with the prostate. The spot whence the specimen was removed showed

a cauliflower overgrowth such as one sees in almost any malignant growth under similar conditions.

Upon removal it was noted that it enucleated quite freely except at one point on the left lateral aspect where it was densely adherent and apparently had infiltrated into the capsule of the prostate. The impression of the authors at the time of operation was that the case was one of malignant growth of the prostate.

The specimens removed when examined microscopically showed granulomatous new-formed tissue rich in plasma cells containing mononuclear giant-cells resembling the Sternberg type, and also eosinophilic leucocytes.

The examination of the enlarged inguinal lymph-nodes showed simple chronic lymphadenitis with no evidence of a granulomatous process like that seen in Hodgkin's lymphogranulomatosis.

#### CONCLUSION

In conclusion the case is described as one in which there occurred enlargement of the prostate gland having the histological picture resembling malignant granuloma or so-called Hodgkin's disease.

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## SUSTAINED COUNTERWEIGHT-TRACTION IN HÆMOSTASIS OF PROSTATECTOMY

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THE very massive hemorrhage incident to the removal of the prostate from the very beginning of the performance of this operation has been controlled by the "quasi" pressure of tampons. The extensive tamponade of the bleeding bed with gauze long enjoyed a popularity. Its drawbacks were the large quantity of gauze employed necessitating a large fistulization of the bladder to effect its eventual removal, a procedure always fraught with pain and which large supra-pubic opening with gauze protruding obviated greatly the chances of an effective syphonage of urine and bladder contents.

With the introduction of the Hagner and Pilcher bags nearly all the aforesaid disadvantages were eliminated. These bags were made to contact with the bleeding surface by drawing taut the rubber tube at its exit from the urethra and maintaining this pull by anchorage to a cradle with its points of support on the pelvis. Now these cradles are difficult of adjustment and cumbersome in so far as they hamper the free movements of the patient and prevent a more intimate investment of the patient with the bed-clothes. To do away with these "cradles" or "anchors" it occurred to me to substitute a more sound mechanical principle, that of counterweight-traction playing over a pulley. The very nature of such traction sustained by counterweight precludes elastic traction; wherefore in the precise application of this principle, rubber bags with rubber tubes attached should be eliminated. The method of application thus follows. Upon completion of the enucleation a Nélaton catheter is introduced until its vesical end becomes visible or felt. To the vesical end drawn into the wound a length of enameled (water-proofed) linen fishing thread is secured. The catheter is withdrawn until a length of thread emerges requisite to pass over the foot of the bed and reach the floor—six foot is adequate for all occasions. To the thread emerging from the abdomino-vesical wound some Penrose tubing is secured by throwing a knot about loosely coiled folds of the tubing arranged in rosette fashion or with greater refinement transfixing loops of tubing with the same thread armed with a large needle. This accomplished, the thread coursing the urethra is pulled upon, causing the rubber tampon to follow until the resistance of the bleeding bed at the introitus of the bladder is met. Traction is then sustained by applying a sand bag of 3 to 5 pounds weight or a vessel with two litres of water (4.4 pounds) to the end of the thread which is allowed to fall over the end of the operating table. A stretch of thread emerges from the bladder wound. All other requirements in the repair of the wound may now be met and then the patient with the pendant

weight is transferred to the stretcher and in turn to bed. The line now passes between the lower extremities almost in contact with the plane of the bed and is guided over a pulley lashed to the foot of the bed with the weight of 3 to 5 pounds attached. It is readily apparent when this complete fixture is in place that the greatest comfort is assured to the patient. He may readily move about without dread or likelihood of displacing anything. The small size of the thread in the urethral canal is never as discomforting as the rubber tubes and if the weight appears to be exercising too great a pressure,

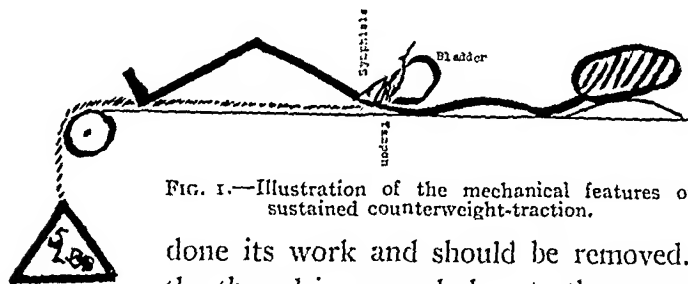


FIG. 1.—Illustration of the mechanical features of sustained counterweight-traction.

it may readily be lessened. At the end of 48 to 72 hours when the hæmostasis should be completed the rubber tubing (Penrose) has done its work and should be removed. The weight is detached, the thread is severed close to the meatus and the thread emerging from the bladder is drawn upon until the tubing appears in sight. By continued gentle traction by a slight torsion of the tubing this will be made to unfold itself and thus readily be removed rather painlessly through the comparatively small opening alongside of the rubber syphon tubing without interfering or displacing the same.

To summarize. Gauze tamponade pressure is illusory because the "point d'appui" (prostate bed) can only be reached continuously if the bladder contracts about a large tampon occupying its interior. Air pressure being equal in all directions, much of the air under pressure in the bags is spent on the interior of the bladder remote from the wound. The methods of suture (Walker) to control hemorrhage by suture of the bleeding surface is ideal in its aim but inadvisable, because the exigencies inherent in most cases do not warrant the long time necessary for its performance.

By the principle of the sustained counterweight-traction pressure is transferred to the rubber tampon and solely centred upon the bleeding area immediately as if it were forcipressure; and the bladder wound is reduced to the minimum and its size being determined by the size of the drain for syphonage. Because of the perfect hæmostasis the size of the tubes need not be as large as those of Freyer or Marion since their large proportions aimed to facilitate the escape of large clots and the channel in which the tubes rested subsequently became the path along which the tamponade of gauze was removed.

Finally, it should be stressed that no special armamentarium is required for the application of this very simple procedure, the mechanical principles of which are set forth in the outline sketch.

# VITAL FACTORS IN THE MANAGEMENT OF PROSTATIC OBSTRUCTION\*

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THE vital factors in the management of the prostatic, demanding serious consideration, concern both palliative and operative measures. It is agreed, naturally, that there is a definite

group of patients with prostaticism, in which operation should not, may not, and cannot be done. To this group, obviously, belong the incipient cases of obstruction, those that are organically and constitutionally unfit for operative intervention and those who refuse operation; collectively they constitute the so-called catheter-life class. It is quite generally recognized that the welfare of this group can be materially promoted by proper diethetic and hygienic measures and by assiduous care in the aseptic employment of catheters and other urethral instruments. That the choice, care and sterilization of instruments; that discrimination between intermittent and continuous catheterization and the frequency and change, respectively, of the

same, or decision between cystotomy and catheterization, that urinary antiseptics, diuretics, hematinics and tonics are important and that gentleness, patience, perseverance and sweet oil, are all vital factors that prolong life, need no particular emphasis. Nevertheless, too often do we see irreparable damage from trauma and infection, due to inexperience and indiscretion. Admittedly, the practice of medicine is both an art and a science, and I am pretty well convinced that there is greater opportunity for art in urology than in some other medical fields, and am quite certain that we ourselves are

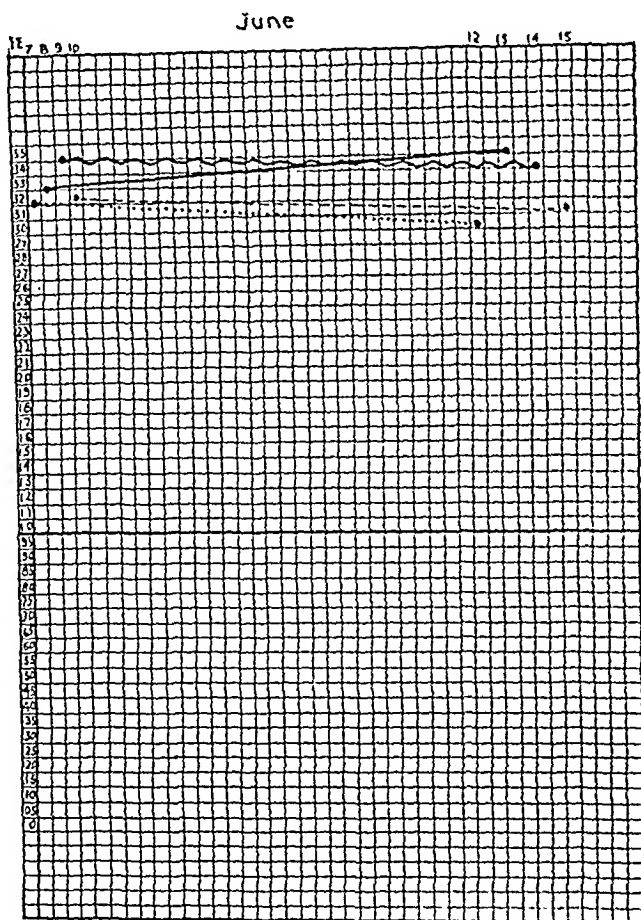


FIG. 1.—Normal case showing parallelism of indices of Elimination of indigocarmine and phenolsulphonephthalein. Indigocarmine: intramuscularly——; intravenously-----. Phenolsulphonephthalein: intramuscularly~~~~~; intravenously.....

\* Read before the Brooklyn Urological Society, March 8, and the Philadelphia Academy of Surgery, May 2, 1927.

frequently remiss in its full application to our daily work. It is not an uncommon experience to-day to have patients on catheter-life for ten, fifteen or more years. Such a régime implies and necessitates the most efficient urologic care and rigid antisepsis.

There can be no urologic surgeon to-day, who questions the fact that the prospect of the qualified prostatic is infinitely better from operation than from any form of palliative treatment. It has been estimated that 50 per cent. of prostatics die in five years of the onset of obstruction, and that

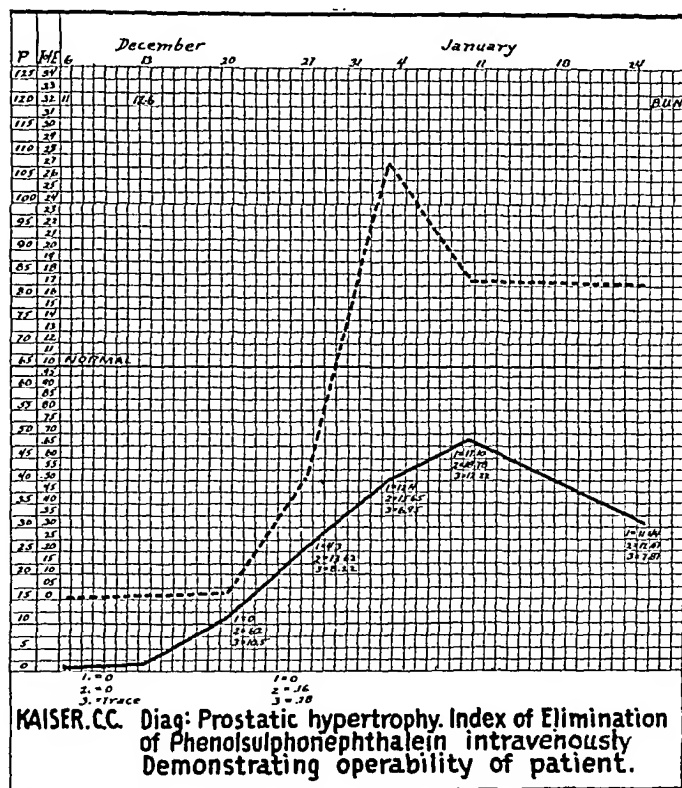


FIG. 2.

considering the age and decrepit state of the average prostatic, that by virtue of advances, chiefly in the preliminary care of these patients, that mortality has been brought so low. It would appear that if further progress is to be made in this respect, prostatectomy must be likened to appendicectomy, and operative measures be resorted to earlier, before other organic complications supervene.

Of importance, rivalling the determination of the operability of the prostatic, is the exact determination of the type of obstruction and the extent of the pathology. Upon this differentiation rests, or should rest, the decision as to the route, or particular type of operation, to be executed in the given case, and this in itself will materially lessen morbidity and mortality. It is a well-recognized fact that approximately ten per cent. of patients with prostatism do not present the classical hypertrophy of the gland so readily diagnosed by rectal palpation, but, on the contrary, belong to that no less

catheter life shortens this to two and a half years. Obviously there are many notable exceptions to this dictum, but the fact remains, that life expectancy from catheter-life runs a poor second to the results following operation, with a mortality of three to five per cent. Moreover, the advantages of operative treatment, aside from those of vital statistics, from the standpoint of morbidity alone, would seem to justify the Golden rule: *operate if you dare to and catheterize only if you must.* It is truly a magnificent tribute to urologists, that, con-

important, although smaller, group characterized by the French as "prostatisme sans prostate," wherein the pathology is usually some form of bar or glandular obstruction at the internal vesical orifice, incapable of exact diagnosis except by cysto-urethroscopy.

The cystoscope, furthermore, will frequently reveal intravesical pathology that will itself decide the route and extent of operative intervention. One of these revelations may be carcinoma, a consideration of which, however, is a chapter unto itself, and will not be discussed at this time; another may be syphilis, and should always be taken under advisement in urinary retention with impalpable prostate; others are diverticulum, hypertrophy of the trigone, tumors, calculus and various obstructions or bars at the vesical orifice.

In a consideration of prostatic obstruction, one may be so engrossed with the study of the particular type of lesion present, as to overlook concomitant pathology, that transcends in importance the prostate itself. The amount and duration of residual urine, and the force with which it is expelled per catheter, are factors often indicative of the extent of bladder damage, which if irreparable, will preclude

a prognosis to the patient, that by operation he will be cured of all his ills. Such unfortunates, fortunately few, will continue to have frequency, harbor infection, and require catheterization and irrigations, or die prematurely. In this connection, I must allude to hypertrophy of the trigone, with pouching of the bladder posteriorly. I have seen and operated three such cases, and believe the condition to be secondary, invariably, to retention of urine, due usually, although not always, to obstruction at the vesical orifice by the prostate or in the urethra. The first case presenting this condition to come under my observation and treatment three years ago, was one of obstruction at the vesical orifice due to prostatic calculi. I have seen and operated two other patients with marked trigonal hypertrophy the past year; both cases of

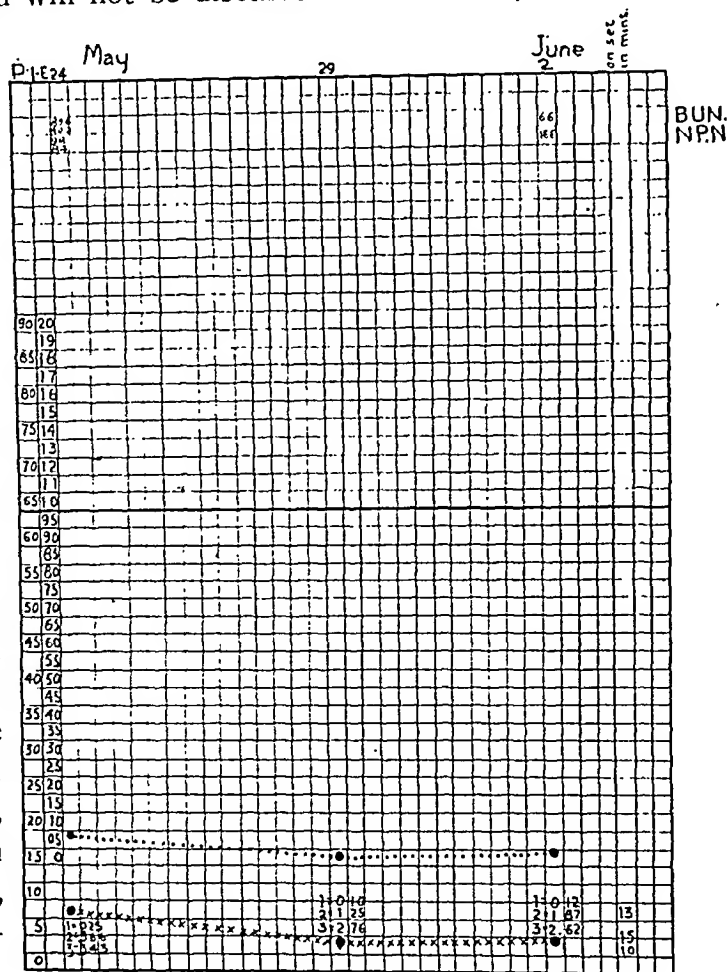


FIG. 3.—J. Huston. Diag. prostatic hypertrophy. Index of elimination of phenolsulphonaphthalein intravenously. Demonstrating inoperability of patient.

obstruction, one glandular, the other fibrotic. The vis a tergo pressure, damaging kidney function and leading to hydronephrosis in these cases of urinary retention, aside from the more immediate threat, when it exists, of ascending infection, pyelitis, pyelonephritis and uremia, not to mention the remote effects on the heart, circulation and lungs, all constitute the possible pathology of the prostatic and are vital factors of first magnitude,

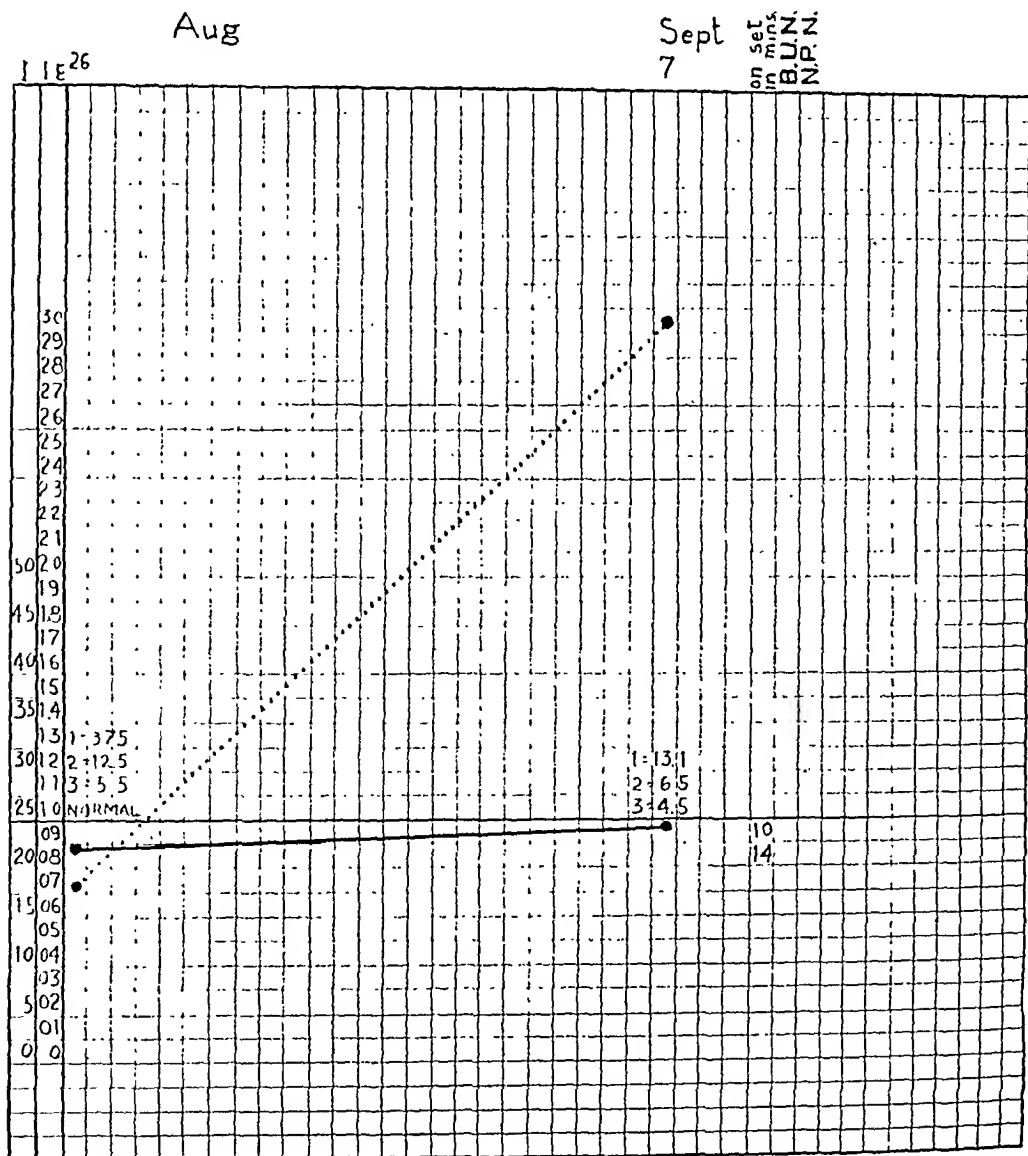


FIG. 4.—F. Stern. Diag. prostatic hypertrophy. Index of elimination of indigocarmine intravenously. Showing rise into positive phase and operability of patient.

when present, but need no emphasis before this audience, for the efficient management of the patient with prostatic obstruction.

Vital factors of great importance come into consideration, in determining the qualifications of the patient for operation. They constitute the estimation of the fitness of the patient for immediate, or deferred operative intervention, or inoperability, because of organic disqualifications. The most



# VITAL FACTORS IN MANAGEMENT OF PROSTATIC OBSTRUCTION

important of these, because at one time the commonest cause of death following prostatectomy, is the determination of the kidney function. Without recounting the various and numerous so-called tests of retention and elimination for this purpose, suffice it to say that the majority of urologists, to-day, are content with the estimation of blood urea nitrogen and the quantitative percentage output of phenolsulphonephthalein. Absolutely normal

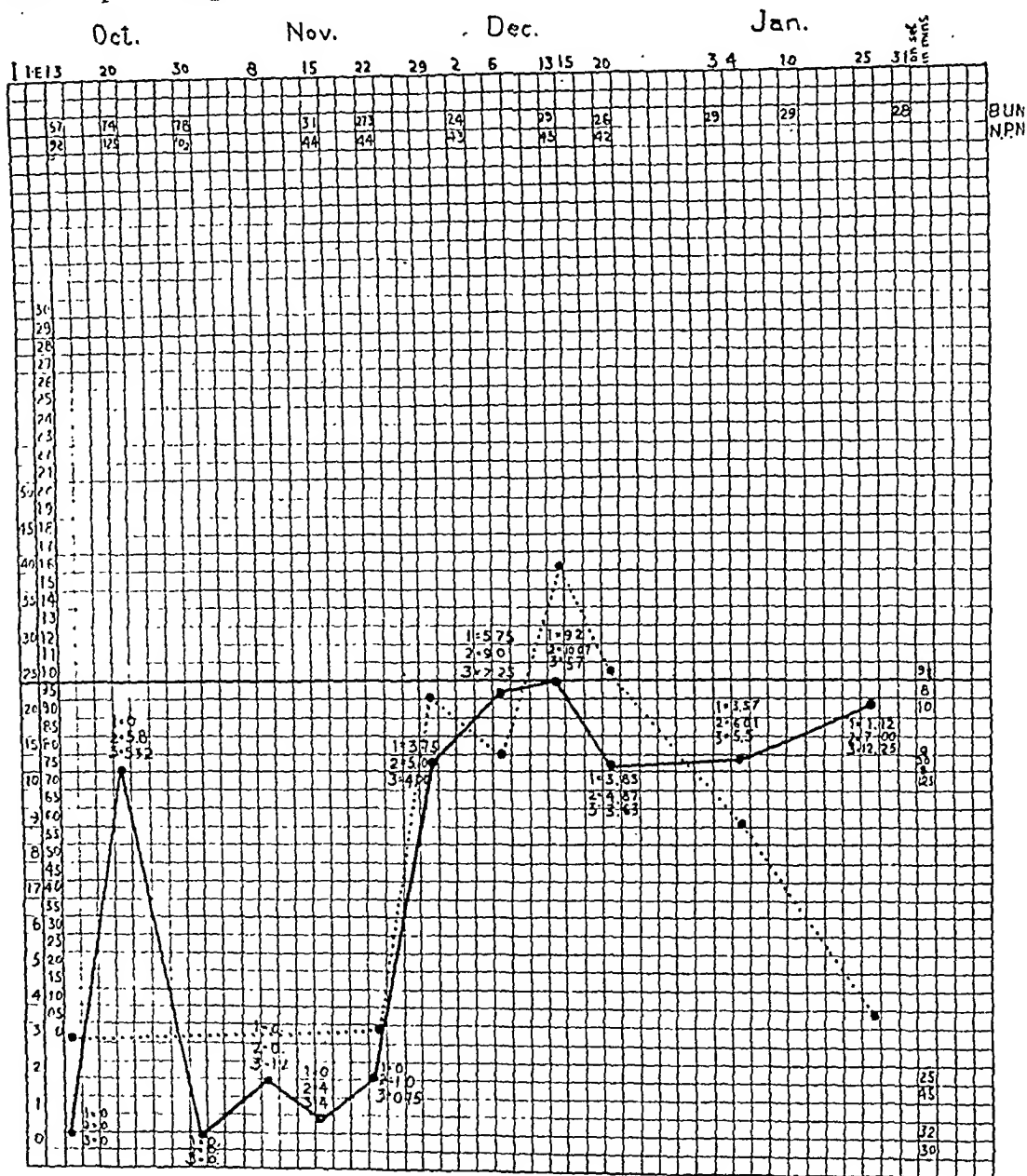


FIG. 5.—A. Huston. Diag. prostatic hypertrophy. Index of elimination of indigocarmine intravenously. Demonstrating inoperability of patient.

values of blood urea nitrogen range from 12 to 20 mgm. per 100 c.c. of blood; safe values 20 to 30 mgm.; values above 30 mgm. should be regarded as dangerous, if not prohibitive, of operation. Relative to phthalein or other substances employed, quantitatively, to determine the kidney function, absolutely safe operative values, so far as I know, have never been laid down. It will not be doubted that a patient with a quantitative output of 10 per cent. last

week, 15 per cent. this week and 20 per cent. next week, is a far better operative risk, than a patient with an output of 50 per cent. last week, 40 per cent. this week and 35 per cent. next week. Thus our aim should be to determine the *stability of kidney function*. This of course can be and is

FIG. 6.

*Blood Pressure Readings in a Series of Prostatectomies*

Systolic		Diastolic		<i>High pressure cases</i>	
A	B	A	B	Systolic	Diastolic
165	135	120	80	(198)	(96)
135	158	80	95	185	80
162	138	93	70	192	95
185	170	80	120	184	86
145	120	80	60	190	90
(198)	130	(96)	70	165	120
142	140	90	84	175	120
175	184	120	86	156	102
152	144	85	72	150	100
170	115	98	72	170	120
156	140	78	80	154	116
115	135	70	80	170	100
155	170	90	90	<i>Rule</i> —When the systolic blood pressure is 180 or above, the diastolic must be under 100; when the diastolic pressure is over 100, the systolic must be 175 or less.	
152	146	85	98		
123	(102)	70	(58)		
156	110	102	65		
120	155	70	90		
167	160	90	95		
155	132	95	95		
116	140	80	85		
130	140	85	88		
135	130	80	65		
115	140	65	95	<i>Low pressure cases</i>	
153	118	60	68		
128	132	85	86	Systolic	Diastolic
100	105	70	65	(102)	(58)
148	128	65	98	100	70
115	154	50	116	110	75
155	120	85	94	105	65
122	126	60	75	110	65
145	118	75	74	109	76
145	170	88	100	115	50
134	146	78	84	170	55
148	190	85	90	<i>Rule</i> —When the systolic blood pressure is 110 or lower, the diastolic must be over 60; when the diastolic pressure is under 60, the systolic must be over 110.	
140	170	98	55		
120	125	70	85		
110	152	75	80		
115	109	80	76		
130	160	80	95		
150	160	100	90		
192	138	95	68		
150	144	65	82		

The figures in parenthesis represent fatal cases.

estimated by repeated quantitative determinations over a period of time, but reliance, in patients with damaged kidneys, cannot be placed upon a single quantitative test.

I desire to bring to your attention again, after ten years of probation, what I have called the *index of elimination*, for the determination of the

# VITAL FACTORS IN MANAGEMENT OF PROSTATIC OBSTRUCTION

functional integrity of the kidneys, believing steadfastly, that from a single estimation, it gives a truer value of the stability of renal function than a quantitative determination alone. The *index* may be defined as the measure of the ability of kidneys to perform a certain load in a given time, against normal. (Fig. 1.) It is computed by taking the ratio of the percentage output of the dye for the first and third thirds of the cycle of major elimination. Normal'y, the index averages about five, that is, there is five times as much output in the first, as there is in the third third of the cycle of elimination, during the first hour immediately after intravenous injection. It is a fractional determination, based upon twenty-minute periods of observation, and its value lies in the fact, that when the kidneys are damaged, the output of phthalein, indigo, or other substance is delayed, the duration of its elimination relatively prolonged, and hence the quantitative output for the first part of the cycle of elimination diminished, sometimes to the vanishing point. When the quantitative output for the first twenty-minute period is greater than, or at least equal to, that of the third period, there has been no urea nitrogen retention in the blood and patients invariably have demonstrated an excellent renal function, and are considered to be in the *positive phase* for operability; when the output of the dye for the first period is less than that for the third period, the index is obviously less than one; the kidneys are damaged, the patient is in the *negative phase*,

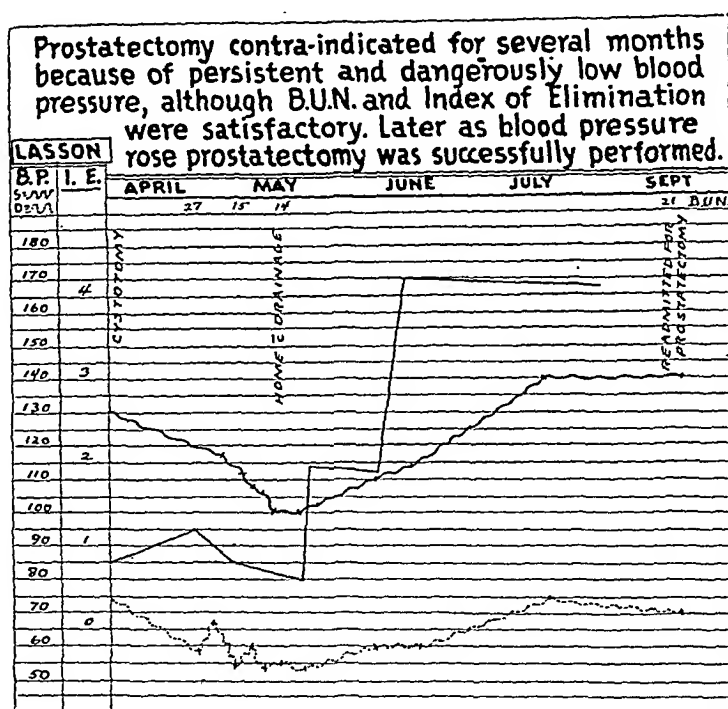


FIG. 7.

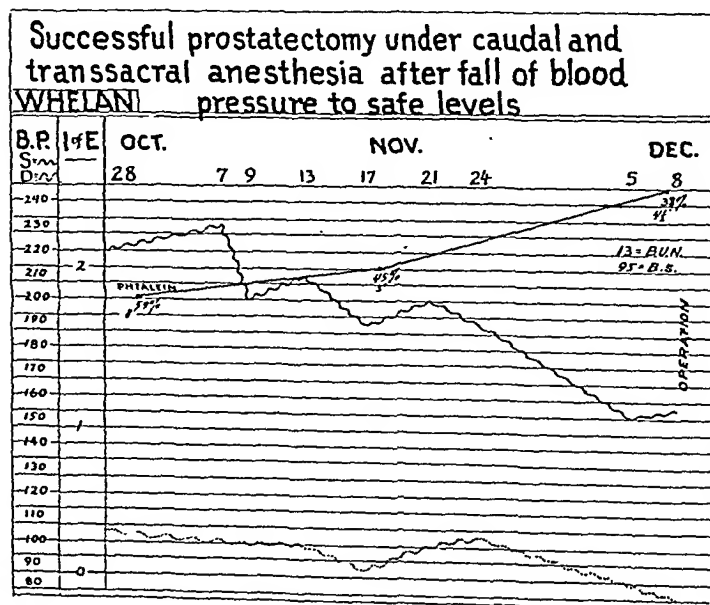


FIG. 8.

considered to be in the *positive phase* for operability; when the output of the dye for the first period is less than that for the third period, the index is obviously less than one; the kidneys are damaged, the patient is in the *negative phase*,

and operation is contra-indicated. Everything depends upon the accuracy of these functional quantitative determinations. The index, or the curve of the indices, in a given case, unquestionably gives a more pronounced, graphic portrayal of the kidney status than the mere quantitative readings—a fact readily demonstrable in the charts. (Figs. 2, 3, 4 and 5.) Indeed, simply by equal dilution of the first and third twenty-minute period specimens, and by observation against the light, it is possible to decide, at once, whether or not the patient is in the "positive" or "negative" phase for operative

intervention—no colorimeter is necessary.

Next to kidney function in importance, as a vital factor in the determination of the qualifications of the prostatic for operation, stands the consideration of the condition of the cardio-vascular system and the blood. Obviously, an acute or advanced endo- or myocarditis, particularly, if attended by lost compensation, would preclude the advisability of opera-

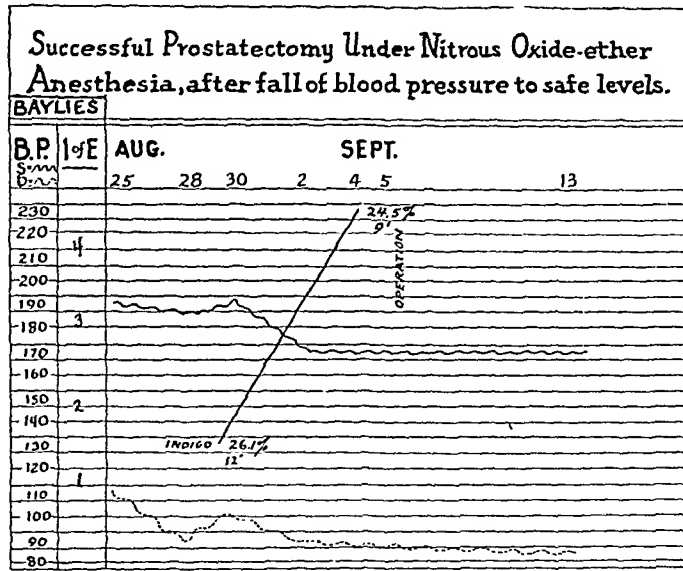


FIG. 9.

tive treatment. From the surgical standpoint, a far more important consideration, frequently encountered, is the question of blood-pressure. I have also stressed this matter on more than one occasion in the past, and as a result of studies into the deaths of prostatectomies, have become confirmed in the following beliefs relative to low and high pressures, in their relationship to successful surgical intervention. (Fig. 6.) *In low tension cases, when the systolic blood-pressure is 110 or less, the diastolic must be over 60; when the diastolic pressure is less than 60, the systolic must be over 110. In high-tension cases, when the systolic pressure is 180 or more, the diastolic must be less than 100; when the diastolic pressure is over 100, the systolic must not be over 175.* This is not so called "pulse pressure," in its usual sense, but rather *pulse pressure with systolic and diastolic limitations.* We have repeatedly, successfully, operated cases with a systolic pressure of less than 110, or even 100, but the diastolic was always over 60; conversely, there have been cases with a diastolic of less than 60, but the systolic was always over 110. (Fig. 7.) On the other hand, operation with a systolic pressure over 190 is a hazardous procedure, but we have done it successfully several times when the diastolic was under 100 (Figs. 8 and 9); conversely, many cases with a diastolic over 100 and as high as 120, have been prostatectomized with recovery, but the systolic has invariably been less than 175.

## VITAL FACTORS IN MANAGEMENT OF PROSTATIC OBSTRUCTION

There are certain conditions of the blood other than nitrogen retention that deserve attention. Even such trivial matters as routine Wassermann tests and determination of the coagulation time of the blood, may enable the patient to receive appropriate antisyphilitic treatment, fortifying his chances for, or even saving him the experience of an operation, and promoting his convalescence; rarely in the detection of a bleeder, life itself may be spared. I have made the examination of the blood for sugar a routine procedure, and have been repaid in a number of cases by finding

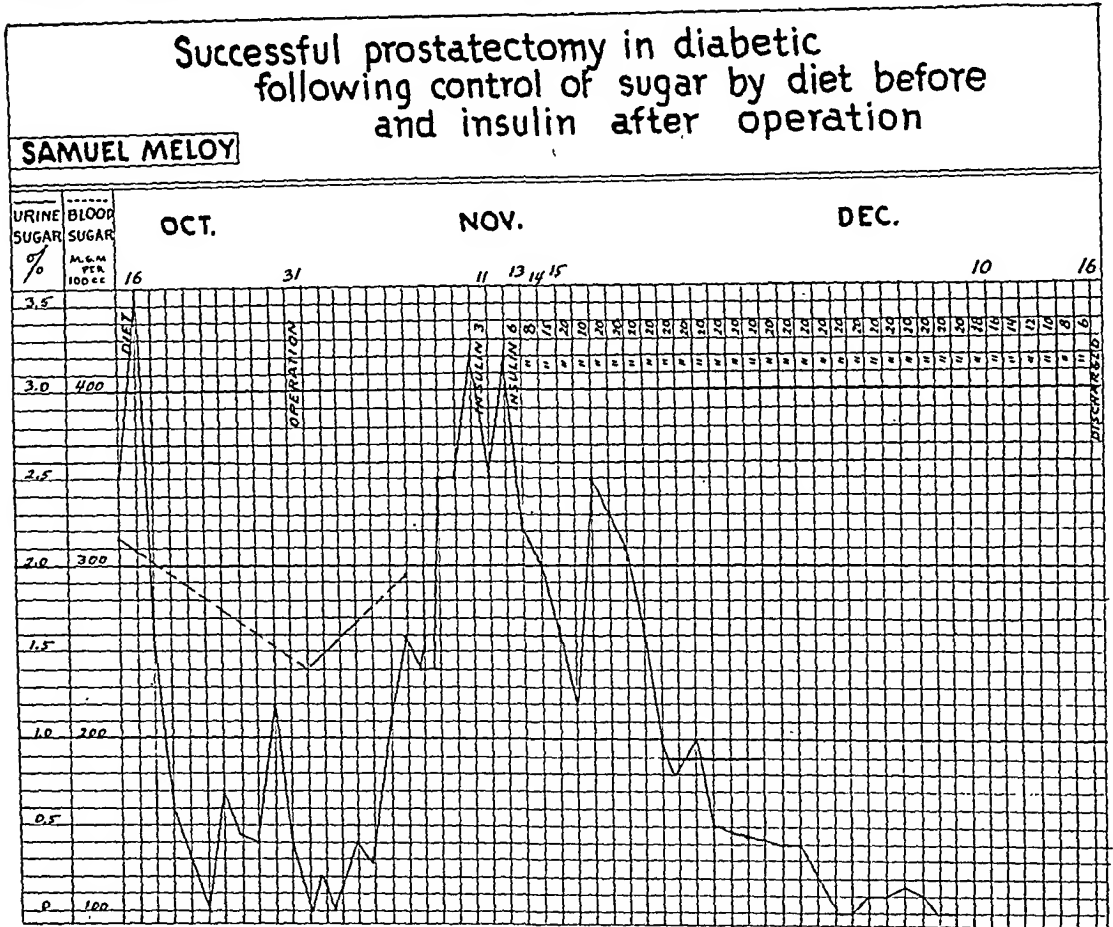


FIG. 10.

hyperglycemias, in the absence of sugar in the urine. The proper dietetic régime, with or without insulin, has sufficed in a number of cases to make surgery safe for these diabetics. Figure 10 represents the diabetic chart of a prostatic, whose urinary sugar prior to operation was controlled by diet, but after operation insulin became necessary and doubtless saved his life. I have also seen a number of patients markedly debilitated and gravely anæmic from the agonies of prostatism, in whom it was possible, in the course of a few weeks of pre-operative treatment, to bring their blood pictures up to normal and safe operative levels. Figures 11 and 12 show the curves of the red blood-cells and hæmoglobin in such cases. By virtue of the parallelism between these two curves, it is not routinely necessary to have the erythrocytes counted. Figures 13 and 14 will illustrate the hæmoglobin

curve in comparison with the index of elimination of phthalein and the blood-pressure of patients qualifying for prostatectomy.

Another vital factor of moment is the nervous system. Organic disease of the central nervous system, as tabes, multiple sclerosis, etc., is easily recognized and should not complicate the management of the prostatic. There is, however, a functional nervous disorder, namely, uncontrollable fear of death, that may itself contra-indicate operation. I have seen two prostatectomized patients die from this cause alone. Panic-stricken with fright, death ensued from nervous shock and

exhaustion. Few patients will be disqualified from the pulmonary standpoint, because of emphysema, hypostatic pneumonia, malignant metastasis, or an old chronic phthisis. Certain pulmonary, like cardiac, contra-indications to general surgical anaesthesia, can be overcome by resort to caudal and transsacral narcosis.

Likewise, the gastro-intestinal tract seldom is a factor in prohibiting surgical intervention on the prostatic. Rarely carcinoma, chronic gastro-enteritis or extreme intestinal stasis will forbid surgical attack.

Age, *per se*, is never a vital factor prohibiting surgery of the prostate. A man is never any older than his organs, and if they are determined to be fit, mere years are no criterion.

Many men are older at fifty than others are at seventy, and some at eighty are younger than others at sixty. Physical dissolution, general organic exhaustion or true senility, assuredly, will preclude any thought of radical surgery.

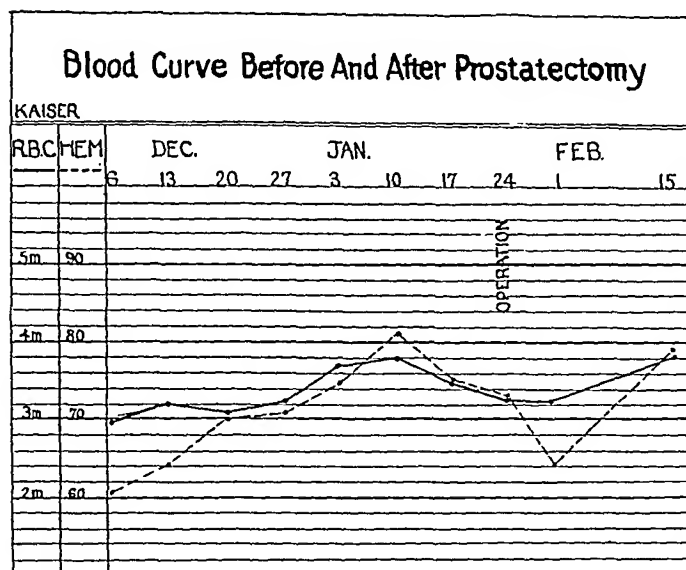


FIG. 11.

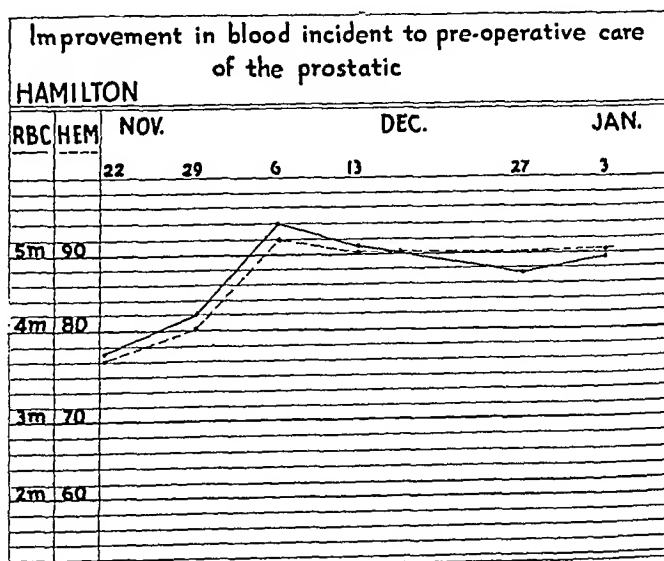


FIG. 12.

VITAL FACTORS IN MANAGEMENT OF PROSTATIC OBSTRUCTION

I believe the vast majority of surgeons, general and urologic, to-day favor suprapubic prostatectomy when there is a preponderant enlargement of the median lobe, or general hypertrophy of the gland, or when other intra-vesical complications exist, as stone, tumor, diverticulum or trigonal hypertrophy. When the hypertrophy is confined to one or both lateral lobes, or the gland is small, fibrotic and presumably densely adherent, undoubtedly it should be removed perineally. (Fig. 15.) I have repeatedly known patients to be cystotomized for prostatectomy and the prostate found to be so small that its enucleation, suprapubically, was pronounced impossible, and the operation terminated. Such surgery would not and could not be done, if patients were properly cystoscoped and more discrimination exercised as to operative route. Again, in that not inconsiderable group, where by the cysto-urethroscope the obstruction is determined to be

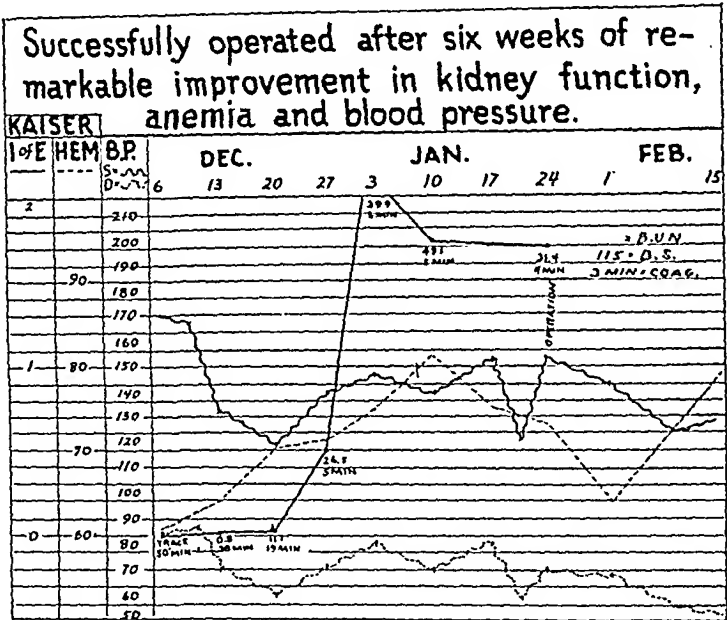


FIG. 13.

Inoperable, in spite of normal improvement, in kidney function and blood picture, because of myocarditis and heart block

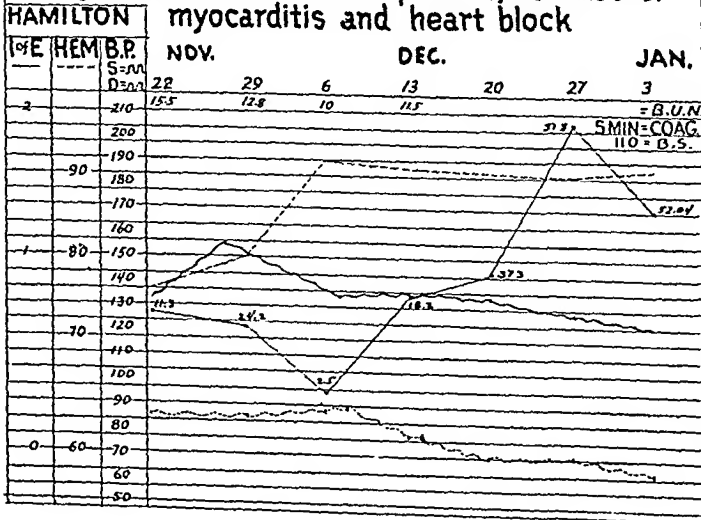


FIG. 14.

better execution under direct vision may be, time only will determine. In many such cases, the orificial obstruction can be more effectively and thoroughly removed suprapubically, by punch or rongeur, with less danger from infection and hemorrhage. (Fig. 16.)

Doubtless everyone will recall that it has been but a few years since prostatectomists were divided into two schools, one that insisted on operating all cases perineally, the other that was wedded exclusively to the suprapubic route. On *a priori* grounds, it was obvious that both could not be right, and for fifteen years I have spoken, written and reiterated the thought, that more discrimination should be exercised, depending upon the pathology present, with respect to selection of the proper operative route in the given case, thereby reducing morbidity and further lowering mortality. If the surgeon will prepare himself impartially to operate suprapubically, perineally, or per urethrally by whatever modality, and stand unbiased and unfettered by training, experience or tradition to operate the patient according to his needs, rather than to fit the victim to operation, to which he is irrevocably wedded

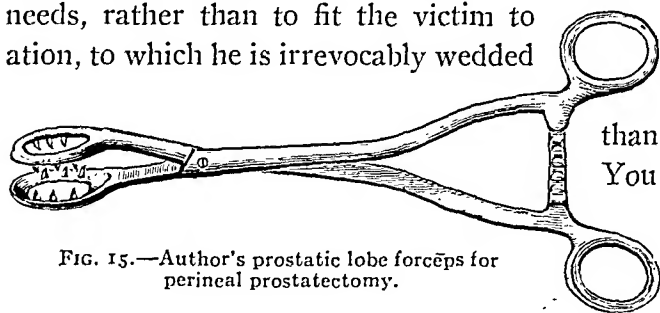


FIG. 15.—Author's prostatic lobe forceps for perineal prostatectomy.

any particular type of operation by reputation, I am positive that even better results, than obtain to-day, will accrue. You have all seen unsatisfactory results from the suprapubic, perineal and "punch" operations, due to incomplete

removal of the offending obstruction. I have operated successfully, by another route, not a few prostatics, primarily operated elsewhere with indifferent results. Exercising all the discrimination possible, with respect to the type of operation to be done in given cases, I also have had the misfortune and humiliation of unsatisfactory results in my own work, necessitating re-operation by a different route. Thus it is evident, that in spite of the greatest care and impartiality in the management of these cases, unsatisfactory results will occur occasionally. Let us endeavor to keep them at a minimum. My experience shows that about 80 per cent. of cases have been operated suprapubically and about 20 per cent. perineally. Almost all bar and glandular obstructions have been removed by "punch" or rongeur *via* suprapubic cystotomy. Caulk, on the contrary, believes that over 30 per cent. of all cases of prostatic obstruction can be successfully treated by the cautery punch, thus eliminating cystotomy in a very high percentage of patients.

The factor that has done most to conserve life in the management of the prostatic, and has been responsible in the past quarter of a century for a reduction of mortality from approximately 50 to less than 5 per cent., is drainage of the bladder to facilitate decompression of the kidneys, and the readjustment of their temporarily damaged function by urinary back pressure. Every surgeon, to-day, I trust, has a full appreciation and realization of this fact. However, there still seems to be considerable difference of opinion and practice, as to the best way of effecting this drainage, whether by catheter or cystotomy. Assuredly, there are many cases where primary cystotomy or so-called "two-stage" prostatectomy is the method of choice



## VITAL FACTORS IN MANAGEMENT OF PROSTATIC OBSTRUCTION

and a life-saving measure. On the contrary, in the large majority of patients, it should not be routine, and is unnecessary from the standpoint of economy, if for no other reason. In my experience, it has amounted to not more than 10 per cent. The decision as to whether periodic or continuous catheterization

or cystotomy for drainage is to be employed, should not rest upon the inexperienced efforts at catheterization by the average hospital interne or resident physician. Many patients pronounced uncatheterizable, or are intolerant to the catheter in the hands of the hospital interne, will tolerate, most satisfactorily, catheterization by an experi-

enced assistant. The complete and final answer to this problem will be Special Wards with a trained personnel, interested only in urology. The indications for cystotomy over catheterization are very simple and clean cut. They are (1) marked cystitis; (2) intravesical complications, as stone, tumor, clots, etc.; (3) epididymitis; (4) stricture and some cases of false passage of the urethra; (5) unusually small or sensitive urethræ; (6) unusually obstructive or impassable prostates; (7) febrile patients or catheter cases developing urethral fever and chill. How is the patient dying following cystotomy as the first stage of the two-stage prostatectomy to be rated in mortality statistics? It would seem to me that such cases must be regarded as prostatectomy deaths. Certainly they will be so considered by the laity.

The operative technic is perhaps the least important item in the management of the prostatic, provided standard methods are followed, and the external vesical sphincter is preserved. I recognize full well, that some urologists routinely employ caudal and transsacral anæsthesia, others spinal and still others, doubtless the majority, adhere to general anæsthesia, either nitrous oxide, with or without ether, or ethylene. Undoubtedly, more discrimination should be exercised in the selection of the anæsthetic for the particular case, whether some form of spinal or regional or general. I am convinced that no

absolute rule employing the same form of anæsthesia for all cases is best. Certain cardio-vascular, renal and pulmonary cases, unquestionably, should be delegated to

FIG. 16.—Author's suprapubic prostate punch. An enlargement of Hartmann's tonsillar punch; most effective for the suprapubic removal of prostatic bars and obstructions.

spinal, regional or other form of narcosis. The vast majority, if properly prepared, stand general anæsthesia under gas, or even ether, very satisfactorily, with no higher death rate than from other forms of anæsthesia. Much depends upon the efficiency of the anæsthetist.

Hemorrhage is not an infrequent cause of death, and much might be said about hæmostasis. The pneumatic bag of Hagner, Pilcher or Ballenger, has its field of usefulness, but suture ligation of the bleeding point, at the time

of operation, is the best and most trustworthy procedure. Packing of the bed of the prostate is the least desirable method and very rarely necessary.

Owing to the incidence of epididymitis as a complication of prostatectomy, some urologists to-day are routinely ligating the vasa differentia or performing vasectomies, prior to or at the time of prostatectomy. I feel that the incidence of epididymitis does not warrant this. When the complication occurs, it has seldom, in my experience, protracted convalescence. Ligation of the vas or vasectomy might, at least, be reserved for recurrent cases.

Suction drainage, a few years ago, threatened to be a universal practice. To-day, with other more simple and less costly devices, with equally good results, it seems not to be an essential. (Fig. 17.)

There is no doubt that the post-operative care of the prostatic is equally as important as the pre-operative or operative, and this is where the urologist frequently has opportunities to display his ingenuity as a plumber of mankind. Saline and glucose solutions, diuretics and cardiac tonics, especially digitalization, save many lives. A great many patients that "go bad" during convalescence, do so, because of improper bladder hygiene. Thorough vesical irrigations, when infection exists, will prevent the development of many cases of pyelitis and pyelonephritis. Finally, do not force these old men out of bed too soon. Many complications of epididymitis and a few of phlebitis and embolism will thereby be averted.

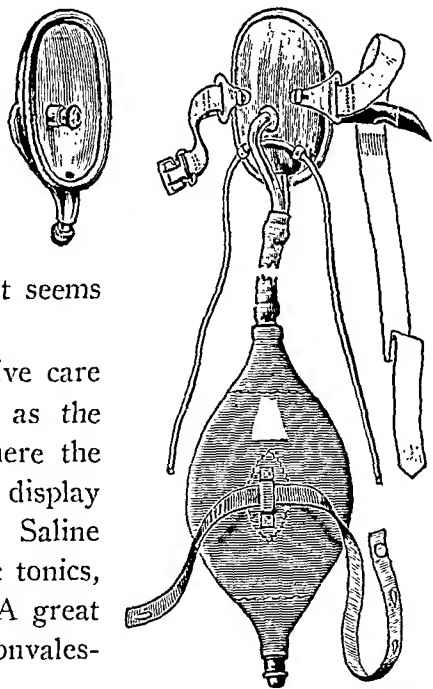


FIG. 17.—Author's suprapubic drainage cup. Routinely used in all suprapubic prostatectomies; a detachable rubber ring cushion applicable to the rim of the cup is not shown in the cut.

# GONOCOCCUS EPIDIDYMITIS

OBSERVATIONS IN THREE THOUSAND CASES FROM THE UROLOGICAL  
SERVICE OF BELLEVUE HOSPITAL

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GONOCOCCUS epididymitis is the most common disease of the testicle. The morbidity is high since sterility following bilateral involvement is frequent. Usually the onset is acute, pain is excruciating and the patient welcomes his bed. An associated urethral discharge suggests the diagnosis; demonstration of the gonococcus confirms it. Treatment is (1) palliative—immobilization of the scrotal contents—or (2) surgical. Epididymotomy affords immediate relief from pain. One in fifteen require operation. Observations on all phases of this disease with particular attention to and evaluation of the various methods of treatment employed in three thousand cases admitted to the Urological Service of Bellevue Hospital are here presented.

Gonorrhœal involvement of the posterior urethra and its associated structures (prostate and seminal vesicles) precedes the epididymitis in all cases even though the appearance of the urethral discharge succeeds the onset of the epididymitis. Several cases of the latter type have been observed and this apparent deviation from the usual sequence betrays a latent posterior infection. We have seen it twice. In eleven of our cases the onset of discharge and epididymitis occurred the same day. The incidence is greater,

TABLE I.

*Interval Between Appearance of Urethral Discharge and Epididymitis—Surgical Cases.*

	0	1	2	3	4	5	6	7-12	Total
Days .....	3	3	4	4	6	7	5	.....	32
Weeks .....		32	35	29	.....	.....	.....	.....	96
Months .....		21	15	7	10	.....	.....	8	61
Over 1 year .....									10
Not stated .....									9
									209

*Non-surgical Cases*

	0	1	2	3	4	5	6	7	8	Total
Days* .....	8	.....	.....	84	.....	.....	.....	53	.....	145
Weeks .....		239	374	311	458	119	239	42	.....	1782
Months .....			268	269	143	.....	27	.....	38	745
Over 1 year .....										37
Not stated .....										58
Denied .....										22
* Epididymitis preceding discharge .....										2
										2791

however, between the second and eighth week of the gonorrhœa, particularly the second to fourth. (Table I.) It is to be noted also that one attack predisposes to succeeding infections of the epididymis. Two hundred and forty-eight of these patients suffered previously with epididymitis, practically always on the same side. Over half (58 per cent.) have had previous gonorrhœas. (Table II.)

In the presence of a deep urethral infection, too forceful injections, the passage of instruments, vigorous prostatic massage, exposure to cold, sexual

TABLE II.

<i>Previous Epididymitis</i>			<i>Previous Gonorrhœa</i>	
Times	Surgical	Non-surgical	Surgical	Non-surgical
1	31	.....	67	1001
2	4	.....	14	408
3	2	.....	5	91
4	..	Same side..... 145	1	48
5	1	Other side..... 64	1	32
6	..		1	8
7	1		..	6
over 7	..		5	52
	39		94	1646

209 surgical cases  
 2791 non-surgical cases  
 —————  
 3000 total

or alcoholic excess may incite epididymitis. Not infrequently direct trauma to the testicle apparently predisposes.

The incidence of this complication may be appreciated by the observation that of 225,000 male admissions to Bellevue Hospital, during the eight-year period on which this study is based over 3000 suffered with gonorrhœal epididymitis, a ratio of one in every seventy-five male admissions.

The incidence is highest during the third decade, the period of greatest sexual promiscuity, particularly between the ages of twenty and twenty-five years. After forty, the condition is rarely encountered. Our oldest patient was sixty-six, the youngest fifteen. Between 20 and 30 per cent. of gonorrhœas develop epididymitis. The ages of our patients in this study are indicated in Table III.

TABLE III.

<i>Ages and Cases of Gonorrhœal Epididymitis</i>		Cases
Age		
15-19.....		152
20-24.....		1231
25-29.....		893
30-39.....		502
40-49.....		84
50-59.....		19
60—and over.....		7
Not recorded.....		22
		3000

# GONOCOCCUS EPIDIDYMITIS

The right side is apparently more often involved than the left. In this series the ratio is 1494 to 1309. Bilateral involvement was noted 192 times. (Table IV.)

*Pathology.*—The migration of the infection proceeds from the meatus posteriorly to the deep urethra thence through the ejaculatory ducts down

TABLE IV.

Side involved	Non-operative cases	Operative cases
Right.....	1390 .....	104
Left.....	1229 .....	79
Bilateral.....	172 .....	26
	<hr/> 2791	<hr/> 209

the lumen of the vas to the epididymitis. Extension of a posterior infection through the lymphatics surrounding the vas may also take place, for we have seen three cases which developed non-gonorrhœal epididymitis (post-prostatectomy) one, three, and four weeks after resection of the vas. The occurrence of localized infection in the epididymis secondary to gonococcæmia has never been proven.

Pathologically, gonococcus epididymitis is nearly always an acute process. On opening the tunica vaginalis, hydrocele fluid often escapes. Fifty-three of the two hundred and nine operated cases in which this finding was recorded showed fluid in amounts varying from 5 c.c. to four ounces. Fibrin in amounts of one dram to three ounces was noted eight times, although it unquestionably occurred more often. Four times sero-sanguinous fluid was found. Free pus was present within the tunica vaginalis six times. (Table V.)

In the early stages, the greatest involvement is found in the globus minor. When mild the infection is limited to this part. When severe,

TABLE V.

<i>Surgical Pathology</i>	<i>Times</i>
<i>Hydrocele present</i>	
1—Fluid: 1 dram to 8 ounces.....	53
2—Fibrin: 1 dram to 3 ounces.....	8
3—Fibrin: (Organized) ½ ounce to 1 ½ ounces.....	4
4—Sero-sanguinous fluid .....	4
5—Free pus in tunica vaginalis.....	6
<i>Pus in epididymis</i>	
Minims 1–15.....	51
C.C. 16–30.....	10
Sero-sanguinous or seropurulent fluid.....	10
Pus found (amount not given).....	27
Abscess of testicle.....	4
Not found nor recorded.....	107

extension to the globus major ensues and often many punctate abscesses are present. By coalescence of these abscesses the entire organ is frequently converted into one suppurating mass. Intense injection of the tunica vaginalis may be seen, but it should be noted that the testicle itself is not involved in the process save by collateral injection of the tunica albuginea. There-

fore, the term gonorrhœal orchitis is incorrect. However, associated abscess of the testicle is occasionally encountered late in the disease but when present develops by direct extension from an abscessed epididymis or is secondary to inflammatory thrombosis of the nutrient vessels of the cord. Not infrequently the cord is of thumb thickness, white and glistening in appearance from œdema, or may show localized abscesses along the vas, particularly in proximity to the tail of the epididymis.

Such cord abscesses we found three times.

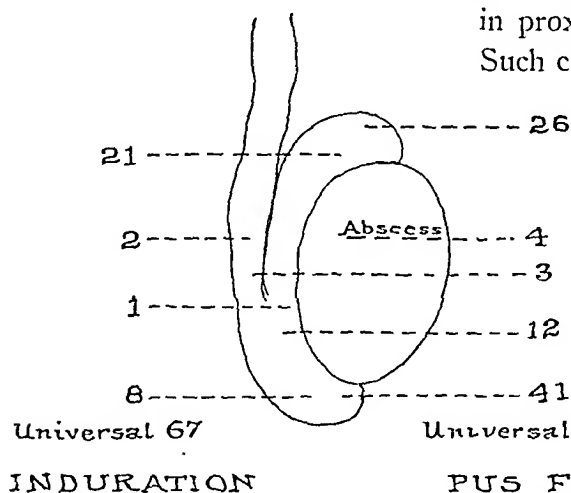


FIG. 1.

Microscopically the picture is that of an acute catarrhal inflammation, *i.e.*, desquamation of lining epithelium, infiltration of polymorphonuclears, plasma cells, and some lymphocytes with generalized œdema of all structures. The seminiferous tubules frequently show minute focal abscesses, sometimes involving but few tubules, more often involving many.

Tubular occlusion by cellular debris or polymorphonuclears is seen. Some tubules are occluded by œdema. Peritubular leucocytic infiltration is also common. The more advanced the disease, the greater the tendency to focal abscess formation.

Of the 209 cases operated upon, regional involvement was greatest at the tail, but a surprisingly large number showed universal inflammation with great pain and without gross pus. (Table VI and Fig. 1.) It is to be

TABLE VI.

*Surgical Pathology*

	Inflammatory Involvement (No Pus)	Gross pus found
Head.....	21	26
Body.....	1	12
Tail.....	8	41
Universal.....	67	23
Head and tail.....	5	2
Head and body.....	—	—
Body and tail.....	—	2
Vas.....	2	3
Not recorded.....	105	90
Abscess of testicle.....		4 times
Sero-sanguinous fluid from epididymis.....		10 times
Cystic epididymis.....		5 times

noted, however, that examination of the sero-sanguinous fluid obtained on puncture of the epididymis in these cases reveals myriads of leucocytes. Examination of the pus or serum obtained has in the hands of many revealed the invading gonococcus. A few attempts to isolate this organism in this series have been unsuccessful.

# GONOCOCCUS EPIDIDYMITIS

*Symptoms.*—Pain is the outstanding symptom in most instances. Quite commonly precursory groin discomfort, pain along the path of the cord, localized ache or sharp stabbing pain in the epididymis is noted many hours or even one or two days before the actual onset of the acute local symptoms. Cord pain is due in part to drag of the testicle but chiefly to oedematous swelling, particularly within the limited confines of the inguinal canal. Pain in the epididymis is severe, best described as sickening in character and may be referred to the lower back, rectum or the lower abdominal region. Motion exaggerates the discomfort. The walking attitude is characteristic, a forward stoop and a straddle gait. Not infrequently the patient finds relief by manual support of the testicle. There are sub-acute cases in which pain is minimal and the patient is oblivious to ought save a mild local swelling. This condition is not infrequent, and unquestionably is, as had been pointed out elsewhere,<sup>1</sup> a frequent cause of so-called idiopathic hydrocele.

The usual clinical course of acute epididymitis is one of an abrupt onset with gradual decline or resolution covering a period of three to five days after institution of proper treatment. The prehospitalization period of the acute disease in our patients is shown in Table VII. Most had the condition

TABLE VII.

## *Duration of Epididymitis Before Hospitalization.*

Days	Non-surgical	Surgical
1.....	223	11
2.....	302	13
3.....	298	44
4.....	322	25
5.....	307	27
6.....	188	13
7.....	381	23
8-10.....	279	12
11-13.....	54	14
14-20.....	225	16
21-27.....	81	4
28-59.....	81	..
Over 60.....	36	5
Not recorded.....	14	2
	2791	209

less than a week when they sought hospital care—one to five days was the duration before admission in half the cases.

Cases in which the temperature and pain does not decline within the three-to five-day period after hospitalization we may usually and correctly diagnose abscess formation. These are best treated surgically.

There are those patients in whom the condition is essentially asymptomatic from onset but these are the unusual. On the other hand, the onset may be most violent with physical signs such as are commonly observed in the acute abdomen, as in two of our cases, or with exquisite pain in the epididymis with chills, fever, nausea, prostration and, rarely collapse.

*Diagnosis.*—As a rule the diagnosis is easily made by finding an acute

inflammatory process involving the epididymis in the presence of an urethral discharge. Demonstration of the gonococcus in the discharge is confirmatory for while acute epididymitis due to other organisms may occur, even in the presence of a gonorrhœal urethral discharge, such cases are most rare and open to question. The scrotum is swollen, often the seat of an acute hydrocele obscuring both testicle and epididymis. The scrotal skin is inflamed and œdematous, usually presenting a reddish-purple hue. The epididymis shows earliest thickening at the globus minor but as the infection proceeds, the entire organ may become involved and easily but tenderly palpable. Cord changes are the rule. (Table VIII.) Thickening was noted 774 times in

TABLE VIII.

*Physical Examination—Spermatic Cord*

	Non-surgical	Surgical
Normal.....	907	31
Tender and thickened.....	556	79
Tender.....	91	11
Thickened:		
Slightly.....	142	22
Moderately.....	295	41
Greatly.....	51	12
Painful.....	32	5
Vas:		
Thickened.....	10	2
Tender.....	5	3
Abscess.....		2
Acute lower abdominal pain with vomiting.....		twice

this series, tenderness of varying degree 463 times. Vas changes are those of induration with enlargement (seven times), occasionally with gross signs of localized abscess (twice).

Changes in the prostate are variable. Prostatitis may usually be correctly diagnosed on digital findings. (Table IX.) Seminal vesiculitis on

TABLE IX.

*Physical Examination—Prostate*

	Non-surgical	Surgical
Normal.....	162	17
Small.....	8	—
Enlarged and nodular.....	273	41
<i>Nodular</i>		
Slightly.....	21	4
Moderately.....	57	8
Greatly.....	12	1
<i>Enlarged</i>		
Slightly.....	72	10
Moderately.....	221	34
Greatly.....	38	6
Indurated.....	141	22
Tender.....	130	16
Boggy.....	162	13

the side of the epididymitis is characteristic, although at times conspicuously absent. Contralateral seminal vesicle involvement may be acute without



## GONOCOCCUS EPIDIDYMITIS

palpable evidence of involvement of the mate we should expect to find diseased. (Table X.)

Urethral smear when positive for gonococci clinches the diagnosis but

TABLE X.

### *Physical Examination—Seminal Vesicals*

	Non-surgical	Surgical
<i>Enlarged</i>		
Slightly.....	542	48
Moderately.....	109	18
Greatly.....	82	6
Enlarged and tender.....	141	10
Tender.....	26	9
Indurated.....	112	3
Involvement on opposite only.....	42	3
Negative.....	179	16

diagnostic exclusion of gonorrhœal epididymitis by negative smear is erroneous. The clinical findings are more reliable. (Table XI.)

Differentiation must be made between gonorrhœal, tuberculous and so-

TABLE XI.

<i>Laboratory Findings</i>	<i>Surgical</i>		<i>Non surgical</i>	
	Smear	Wass.	Smear	Wass.
Positive.....	164	2	1372	21
Negative.....	21	9	101	82
Not recorded.....	24	200	1318	2687

called non-specific epididymitis (*B. coli*, staphylococcus, etc.), particularly in the subacute cases. Prostatic and seminal vesicle palpation, together with examination of the centrifugized urine for gonococci, tubercle bacilli or *B. coli* or other organisms may aid in making the diagnosis in difficult cases. The complement fixation test, generally positive within two weeks after onset of the epididymitis but always sooner or later, must not be overlooked. Tuberculin may rule out or prove a tuberculous infection. Testicular tumor, or luetic orchitis may simulate a subacute epididymitis. Torsion of the spermatic cord is often clinically quite indistinguishable from epididymitis except for absence of signs of a gonococcus infection.<sup>2</sup>

*Prognosis.*—The mortality is low. Death seldom follows gonorrhœal epididymitis, although a few fatalities from secondary peritonitis or septicaemia are on record. In this series there were no deaths.

On the other hand, the morbidity is high, particularly because so many of these patients are rendered sterile. Benzla<sup>3</sup> in studying the offspring of German soldiers found that 10.5 per cent. of those who had gonorrhœa without epididymitis were childless; 23.4 per cent. with unilateral and 41.7 per cent. with bilateral epididymitis were childless. This suggests but does not prove male sterility. In cases of sterile marriages, the male is at fault 15 to 20 per cent. and unquestionably most of such sterility results from previous epididymitis (usually of venereal origin) with occlusion of the seminiferous

tubules. We are now engaged in a follow-up study of twenty-six bilateral operated and 172 bilateral unoperated cases in this series which will be reported later.

*Treatment.*—Prophylaxis aims to keep an anterior urethritis from

TABLE XII.

*Treatment.*

	Surgical	Non-surgical	Pain Relieved Hours after Suspensory
Suspensory used.....	191	2339	1-4 ..... 418
Suspensory not used or not recorded.....	18	402	5-8 ..... 832
Aolin.....		50	9-11..... 362
			12 ..... 371
			18 ..... 22
			24 ..... 224
			30 ..... 22
			36 ..... 31
			48 ..... 57

becoming posterior. If posterior infection does develop, extreme caution and gentleness are essential in carrying out instrumentation. Certainly no instrument should enter the canal during the acute stage of the prostate massaged.

When the epididymitis is present in full bloom, the patient is put to bed and the testicles immobilized. Ice cap to the inflamed parts may relieve as will a hot water bottle occasionally. Splinting of the scrotal contents is, however, the measure for rapid relief from pain. This is accomplished with the adhesive dressing the Urological Service at Bellevue-Alexander muslin suspensory.<sup>4</sup>

The construction of this dressing is simple. (Fig. 2.) It is of adhesive tape of dimensions indicated with a small roller bandage  $2\frac{1}{2} \times 1$  inch so placed that it will fit angle, the object being to lend support to the scrotal contents and to prevent these from slipping downward. With this support the lower roller bandage high in the scroto-perineal angle, the lower strap are brought through the gluteal folds over the hips (Fig. 3) and the broad strap which in reality gives the suspension is brought up over the iliac crests (Fig. 4), thus holding the testicles high with firm support and complete immobilization. An additional cross strap suprapubically reinforces the dressing. This is the only dressing of which we are aware that will afford instantaneous relief from the acute pain of epididymitis.

To ascertain the best treatment for this condition certain therapeutic experiments were carried out at Bellevue. In 1924, Dr. J. J. Toomey made

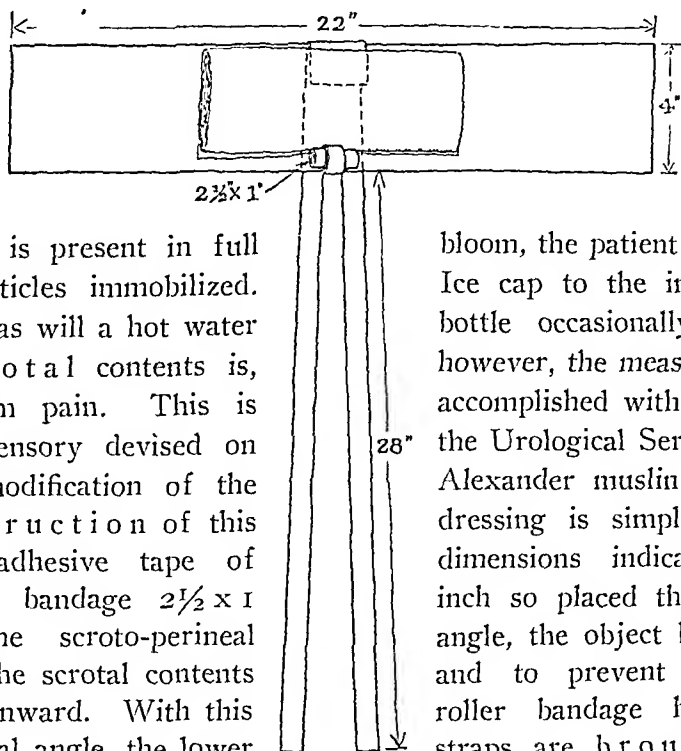


FIG. 2.

## GONOCOCCUS EPIDIDYMITIS

observations on the use of foreign protein by injection. A preparation called aolin was used. In a series of fifty cases thus tried no evidence was brought forth to prove superiority or particular value for this method of treatment. The average hospital stay of the aolin cases was 5.6 days, of those without aolin 5.4 days. If fifty cases treated without suspensory but with ice cap, pain persisted longer and the course of the disease was materially longer (6.8 days) than in those cases having suspensory. In 100 cases with suspensory, no difference was noted in the period of hospitalization in those fifty patients supplied with an ice cap and those fifty without. Those with the cold were more comfortable.

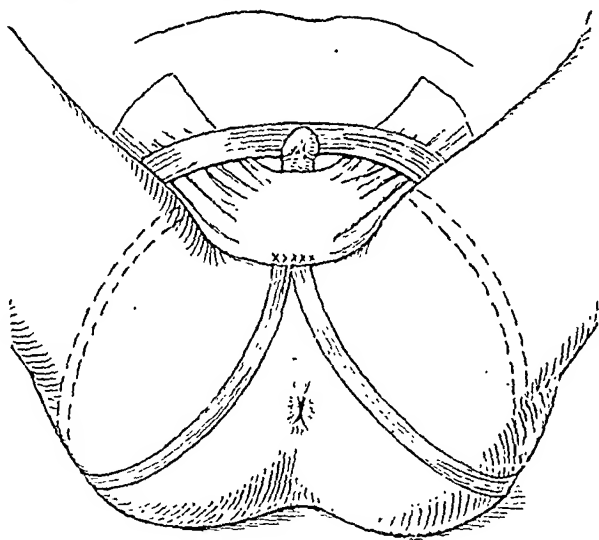


FIG. 3.

More recently observations have been made in a series using diathermy. While pain was often relieved in a comparatively short time, usually only

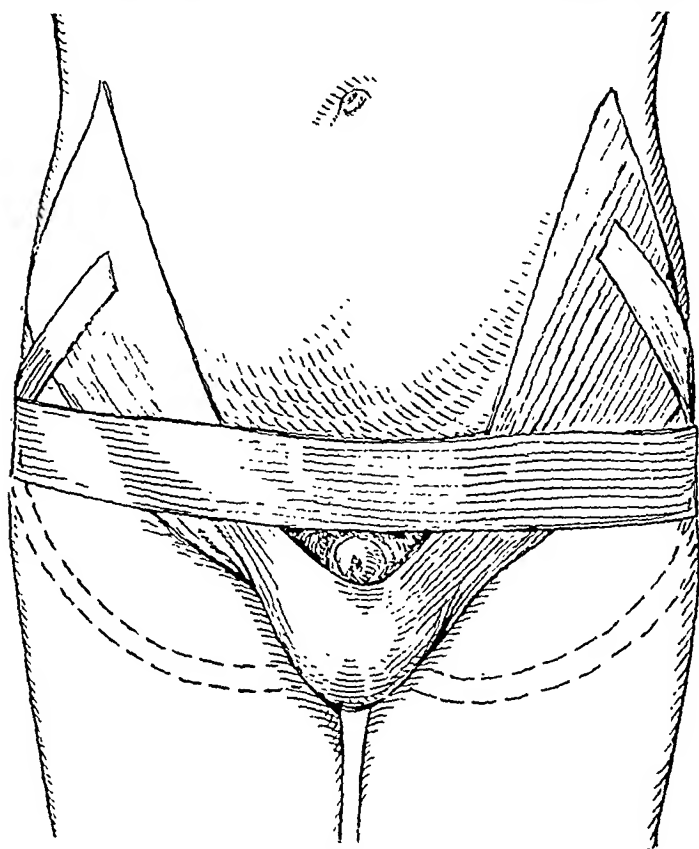


FIG. 4.

temporarily, the course of the disease was not shortened. As a result of this rather extensive therapeutic study we feel that the properly applied adhesive suspensory here described plus rest in bed is the best non-surgical treatment for gonorrhoeal epididymitis.

A host of other therapeutic agents have been advocated. Vaccines—autogenous, stock or typhoid—in increasing doses every other day have been used with inconstant success. Applications of an irritant to the scrotum (quiacol 50 per cent. in glycerin is

most commonly used) serve but to irritate the skin. A tight rubber compression bandage about the scrotum producing a modified Bier's hyperæmia

has been found useful by some. Sodium iodide intravenously has often been used, but neither at Bellevue nor elsewhere have we been convinced of its efficacy.

The problem of surgical treatment is unquestionably the most difficult—when to operate. At Bellevue the persistence of pain has become our criterion. (Table XIII.) If pain does not disappear within forty-eight hours

TABLE XIII.

Indication	Operation.		Anæsthetic
1. Pain and temperature.....	29	Local.....	22
2. Pain.....	161	Gas oxygen ether.....	18
3. Recurrence.....	9	Local to general.....	5
4. Abscess.....	4	Spinal.....	2
5. Not stated.....	6		
Type of Operation			
Epididymotomy.....			178
Epididymectomy.....			24
Orchidectomy.....			5
Resection of Vas.....			1
Additional operation:			
Hydrocele.....			1

after confinement to bed and application of the suspensory without local signs of abscess formation, the case is deemed surgical. Some time ago a non-subsiding temperature was the criterion, but pain has been found a much better guide.

On admission the temperature ranges between 99° and 102° in half the cases. (Table XIV.) After twenty-four hours in bed with suspensory

TABLE XIV.

		<i>Temperature.</i>		<i>Days to normal</i>			
Under 99.....		168		1 .....		1724	
99- 99.9.....		588		2 .....		628	
100-100.9.....		582		3 .....		171	
101-101.9.....		597		4 .....		60	
102-102.9.....		307		5.....		23	
103-103.9.....		392		6 .....		14	
104-104.9.....		142		7 .....		42	
105- .....		15		A.O.R.....		129	
<i>Flare-ups.</i>							
Day.....		3	4	5	6	7	8
		40	28	48	22	8	6

Most of these subsided within three days. Those not subsiding were treated surgically.

over half of all cases will show a normal temperature. At the end of forty-eight hours three of every four will be normal. Temperature flare-ups, however, are not uncommon but usually subside within three days. On the other hand, patients may have considerable pain—enough to keep them awake nights—without temperature. These cases we deem operative and a surprising number show gross evidence of early abscess formation. It is for this reason that pain sufficient to keep the patient awake the second night is our criterion for performing epididymotomy in those cases not grossly suppurating.

Quite aside from the operative risk it has been urged by many that surgi-

## GONOCOCCUS EPIDIDYMITIS

cal interference entails sterility of the involved organ. Later observations on cases having bilateral operation seem to have dispelled this feeling and a statistical study of results obtained show that sterility after operation is certainly no greater than without operation and some<sup>s</sup> present data to prove aspermia is less frequent following epididymotomy. Surely sterility is no greater with operation and the attendant discomfort and danger of such secondary complications as suppuration and subsequent loss of the testicle are minimized by early opening when indicated.

Acute pain in some of these patients has been relieved by subcutaneous puncture of the epididymis. Although quite satisfactory, it is a blind surgical procedure, palliative in many cases (some have required open epididymotomy later) and is not recommended for general use. Open epididymotomy by the method of Hagner<sup>6</sup> is the procedure of choice. It is relatively simple, effectual, does not incapacitate the patient for long and will save not only many epididymes from suppuration but not a few testicles from secondary involvement.

Briefly this method of epididymotomy consists in the exposure, delivery and multiple puncture of the involved epididymis. (Fig. 5.) A Hagedorn

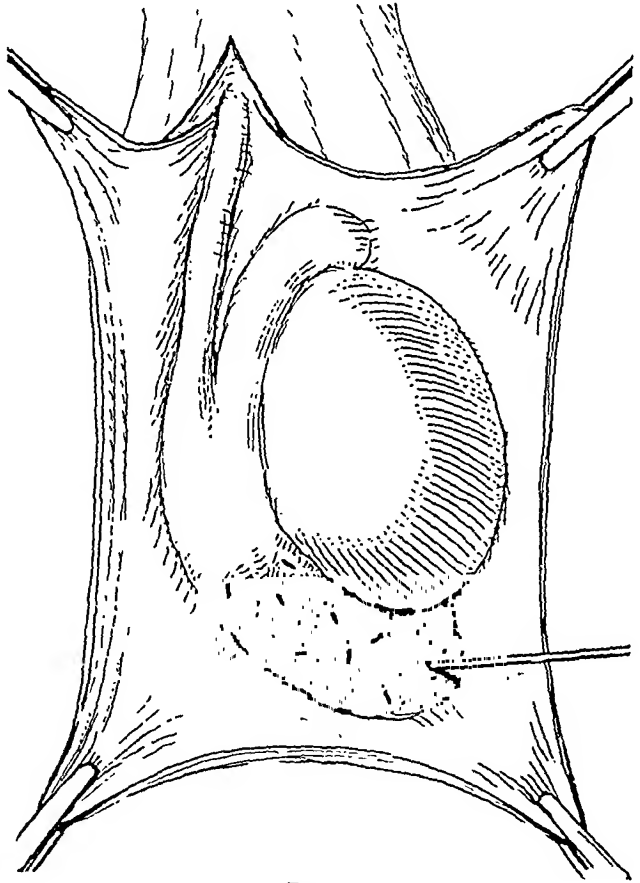


FIG. 5.

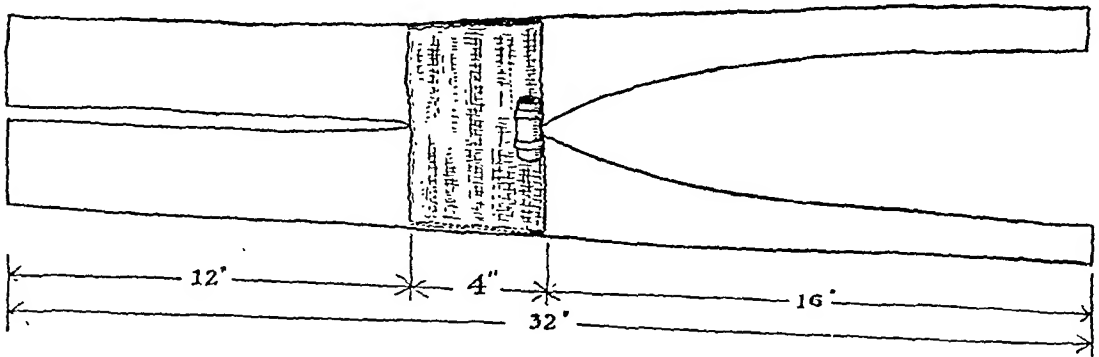


FIG. 6.

needle serves admirably for making the punctures. Relief is afforded by relaxation of capsular tension about the organ with liberation of a certain amount of serous fluid. Droplets of free pus are often encountered and a

small incision into such punctate abscesses is advised. Following puncture, the organ is replaced in the scrotum and the incision closed with a small cigarette drain at the lower angle. The scrotal hæmostatic compression bandage also devised on the Urological Service at Bellevue is then applied.<sup>4</sup>

Essentially a four-tailed adhesive bandage of construction and dimensions indicated in Fig. 6, and fitted with a roller which is placed snugly high in the scrotal-perineal angle (Fig. 7) the lower straps are fastened to the

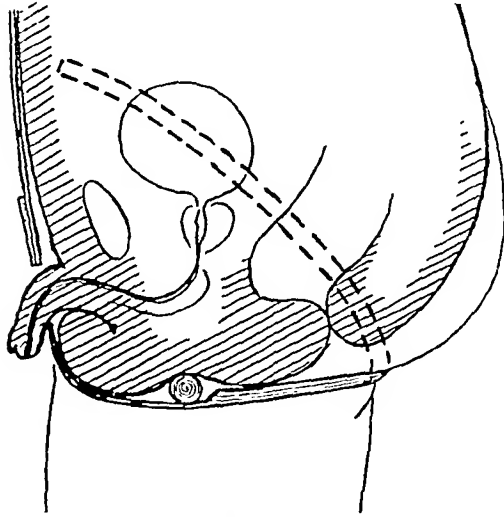


FIG. 7.

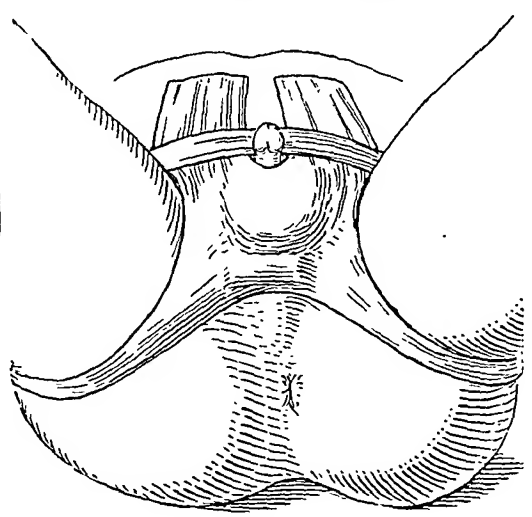


FIG. 8.

skin through the gluteal folds and brought around over the hips. (Fig. 8.) The upper wider straps are brought up over the anterior abdominal wall, hemming in the scrotal contents firmly on each side. (Fig. 9.) An additional cross suprapubic strapping lends support and adds materially to the compression brought upon the scrotum. This dressing has practically eliminated post-operative scrotal bleeding at once so distressing and at times alarming and so frequently occurring in the loose tissues of the scrotum.

Post-operative care requires but the removal of the cigarette drain after twenty-four hours and the removal of the sutures on the fifth day. Most of these patients are sent home on the sixth day, the average period of hospital residence in uncomplicated surgical cases being 7.5 days, of all our cases 3.8 days as shown in Table XV.

TABLE XV.

*Period of Hospitalization*

Days	Non-surgical	Days	Surgical
1.....	321	2.....	2 (A.O.R.)*
2.....	528	3.....	1 (A.O.R.)
3.....	673	4.....	7 (A.O.R.)
4.....	482	5.....	21
5.....	310	6.....	91
6.....	117	7.....	41
7.....	135	8-13.....	35
Over 7.....	225	Over 2 weeks†.....	11
Average.....	3.8 days.	Average.....	7.5 days.

\* A.O.R. Left Hospital. "At Own Risk."

† Longest hospitalization 49 days. This patient had an epididymotomy followed by epididymectomy with subsequent infection and orchidectomy.

## GONOCOCCUS EPIDIDYMITIS

*Complications.*—Scrotal infections—superficial and deep—frequently follow operation. The former cause no distress, the latter sometimes involve the testicle with abscess formation, necessitating orchidectomy as occurred eight times in this series. Thrombosis of the cord secondary to collateral inflammation occurred four times with gangrene of the testicle.

Recurrence after epididymotomy is a comparative rarity and in these cases epididymectomy is usually indicated, particularly when the symptoms are severe. (Table

XVI.) Many patients have multiple recurrent attacks of subacute type, the pain lasting but a few hours. These are best left alone. We did repeated epididymotomies twice in this series and epididymectomy three times for recurrence following primary epididymotomy. For recurrent epididymitis without operation epididymectomy was done six times. In private practice and with a more intelligent class of patients one would be less liberal in doing epididymectomy for recurrent attacks.

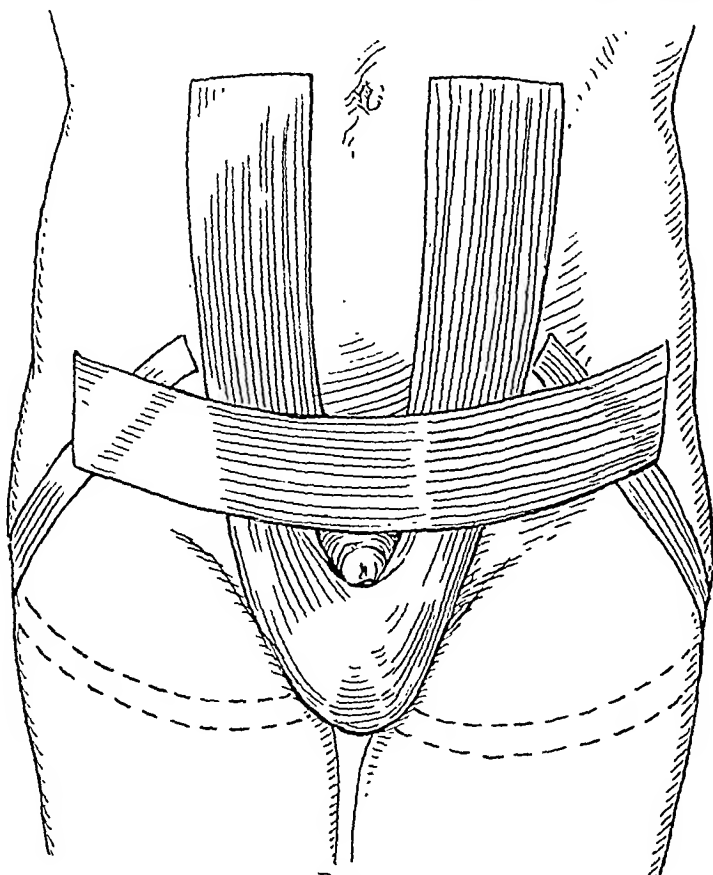


FIG. 9.

The only cure of post-epididymitis sterility lies in operation. An epididymotomy by the method of Martin has helped in some cases. None of our cases has been so treated.

TABLE XVI.

Re-operation	Complications.
Following epididymotomy:	
Epididymectomy.....	3
Orchidectomy.....	5
Epididymotomy repeated.....	2
Scrotal abscess (infected hæmatocele?).....	5
Following epididymectomy:	
Orchidectomy.....	1
Abscess of Vas (Incision and drainage).....	2
Pain:	
First operation partial epididymectomy. Second operation, total epididymectomy. Pain still persists.....	1

*Subsequent Treatment.*—During the acute period of the inflammatory process all local urethral treatment must be stopped. Rarely is it wise to

resume this until a month has elapsed, although sometimes we institute treatment by the third week. It must be done with greatest caution and gentleness as acute flare-ups are not infrequent following resumption of urethral injections. Instruments must be withheld from the urethra for a much longer period. Prostatic massage is attempted with considerable trepidation until at least six weeks have elapsed. Therefore, equally great care and skill must be exhibited in the subsequent treatment of the epididymitis patient as in the original attack since recurrences from ill-usage are frequent.

Acceleration of resolution and resorption of the exudate is best achieved by the use of the adhesive suspensory for at least ten days after the patient leaves his bed. Palpable post-inflammatory infiltration of the epididymis persists for at least six months after the acute attack, not infrequently for life.

In conclusion then, gonorrhoeal epididymitis is a pandemic disease of early adult life occurring with slightly greater frequency on the right side, approximately one in fifteen are bilateral, and approximately the same percentage require operation. Rest in bed, splinting of the scrotal contents by the adhesive suspensory described and the application of an ice cap—all without urethral treatment—constitutes the best method yet devised for the non-surgical treatment of this condition. Epididymotomy affords immediate relief from pain and, in the average case, hospitalizes the patient but 3.7 days longer than non-surgical treatment.

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# TUBERCULOSIS OF THE KIDNEY IN PREGNANCY\*

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A REVIEW of the literature shows us that cases of tuberculosis of the kidney associated with pregnancy are so seldom reported as to be regarded as rare. Owing to the lack of systematic grouping and classification of cases in which this lesion is associated with pregnancy, it is difficult to determine the frequency with which it occurs. James Israel and W. E. Stevens each report two cases, no other authors having reported more than one. In 3103 patients at the Stanford Clinic only one case was found. Some writers believe that there is a natural resistance of pregnant women to tuberculosis. The contrary is, however true, pregnancy is more than likely, as a result of increased physiological activity to light up any old focus of tuberculosis.

In a careful survey of the records of an institution with a large maternity service, 6000 consecutive records show not one case diagnosed in pregnancy—note the word diagnosed, it is highly significant.

In attempting to judge the frequency of these cases, Werboff emphasizes the necessity of remembering cases in which interruption of pregnancy was undertaken owing to renal symptoms. The real causes of these cases are often undetermined. It being a fact that renal tuberculosis is more common in women; would it not seem natural to accept the theory that exacerbations are caused by pregnancy.

In all renal affections of pregnancy the right kidney is most often affected. This is also true of renal tuberculosis.

*Symptoms.*—The peculiarities of symptomatology in renal tuberculosis during pregnancy are largely due to the changes in the urinary passages during this period. In the majority of pregnant women suffering from this disease, the first symptom is pollakiuria usually of the painful type. Undue frequency of urination is not uncommon in normal gestation. It is, however, usually painless and diurnal. In the tuberculosis of the kidney in pregnancy it is both day and nightly.

Pyuria is so often associated with other diseases that in itself it has little significance in diagnosis. Hæmaturia is a fairly frequent occurrence and is often one of the first symptoms noted. It must, however, be distinguished from the hemorrhages of the bladder and urethra frequently seen in pregnancy. A few authors speak of violent renal pains during the course of the disease. In one of Israel's cases renal colic was noted during the first weeks of pregnancy. In this case interruption of the pregnancy resulted in making the intervals between the attacks more prolonged. Fever as a symptom is present to a greater degree and with greater constancy than in ordinary renal

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\* Read before the Southeastern Clinical Society of New York, May 10, 1927.

tuberculosis. The temperature often runs around 40° F. and is hectic in nature. Small quantities of albumin so characteristic of renal tuberculosis appear frequently, particularly in the latter months.

The most important finding is of course the tubercle bacillus. Some investigators believe that the organism is found in 100 per cent. of their cases. Others (and this is more likely) have found it in only 20 to 25 per cent. But even the finding of the tubercle bacilli does not clinch the diagnosis, as bacilli may also be found in excreting tuberculosis and in the so-called tubercular nephritis.

Gratke reports a case in which the presence of leucocytes, erythrocytes and tuberculosis in the urine was made the basis of a diagnosis. Excision of the kidney revealed no evidence of tuberculosis. The tuberculin test is not of very great value in this particular lesion. This is because of a greatly reduced sensibility of the pregnant to tuberculin.

A very important procedure in these cases is vaginal palpation of the ureters. This is a field which has been so well discussed by A. M. Judd. Investigation in this way will usually locate the diseased side. An increased irritability of the corresponding ureter is usually present in the very early stages, and before any bladder changes have developed. It has been said that the ureters are sensitive in an ordinary pregnancy. This is true but they are not painfully so. We must also study this symptom in the differential diagnosis of stone.

Renal function tests may be dismissed as of little value as these are so commonly affected by ordinary pregnancy.

Cystoscopy and ureteral catheterization are not contra-indicated during pregnancy except perhaps just before delivery. Even this is doubtful. We believe that these extremely valuable procedures should never be neglected. Failure to use them probably accounts for many undiagnosed cases of the disease under consideration. Ureteral catheterization and pyelography gives us the only certain information regarding the condition of the kidneys.

*Diagnosis.*—In diagnosis the following diseases must be considered. Acute pyelitis—this usually does not appear until the latter half of pregnancy. Renal tuberculosis usually manifests itself very early. Pyonephritis, renal calculi, glomerulonephritis and tumors can all be ruled out by a careful complete urological examination.

*Treatment.*—In reference to treatment, the physician has three courses open to him: (a) Palliative. (b) Conservative. (c) Radical.

In the conservative treatment one merely adopts an expectant attitude giving symptomatic treatment until the end of pregnancy, a method only to be adopted where no competent assistance is at hand.

The palliative treatment consists in the emptying of the uterus in order to do away with the injurious effect of pregnancy on the tuberculous process.

Radical treatment consists in nephrectomy or a combination of abortion and nephrectomy. Removal of the kidney is certainly the method of choice

## TUBERCULOSIS OF THE KIDNEY IN PREGNANCY

in unilateral renal tuberculosis. The conservative measures should be reserved for bilateral affections or for tuberculosis of a remaining kidney.

Mirabeau believes these indications hold good in both the pregnant and non-pregnant. A review of the literature shows that in 69 per cent. of cases in which exacerbation of unilateral tuberculosis occurred during pregnancy, abortion or nephrectomy became immediately necessary. Thus it would seem that pregnancy instead of increasing the necessity for conservative treatment of renal tuberculosis would contra-indicate it. As the renal process is acutely exacerbated in 71.1 per cent. of the cases immediate intervention is urged. Certainly interruption of pregnancy does not stop the tuberculosis process, and this procedure is particularly dangerous during the latter months. After careful consideration and an extensive experience in the renal affections of pregnancy we unhesitatingly recommend nephrectomy in these cases of tubercular infection. We have examined the records of thirteen cases in which nephrectomy was performed by others. In this group of cases eight resulted in an uninterrupted pregnancy and delivery at full term. In four, abortion had to be resorted to after the nephrectomy. The remaining case is vague. Of the three cases we have observed, two went to full term following nephrectomy. The third was aborted at the fourth month, the patient dying one month later. If good results are to be expected from nephrectomy the opposite kidney should be normal. A suspicion of bilateral involvement is a distinct contra-indication for surgical removal of the kidney. We do not believe that pulmonary tuberculosis is an indication to abstain from surgery, unless the process in the lungs predominates. Each case, however, is a law into itself.

As to nephrectomy and abortion. We do not believe this combination is justified, as some advocate. We believe the latter only permissible where the patient refuses nephrectomy or when an infection of the remaining kidney is found following nephrectomy. As to future pregnancies, we believe their avoidance is eminently proper.

*Tuberculosis and the Child.*—The result of the tuberculous infection on the course of pregnancy and on the child in a series of four cases not operated upon was as follows:

Abortion occurred in two cases, one child was infected at birth and subsequently died of tuberculosis, one normal child was delivered at term. This certainly demonstrates the advantage to both mother and child of immediate nephrectomy.

*Results of Nephrectomy.*—From the cases collected by Stevens the conclusion may well be drawn that pregnant women stand the operation particularly well. It is apparently no more serious than when attempted in the non-gravid state. Following the removal of a kidney as here considered, Stevens urges that tuberculin be administered, the urine examined for a considerable period of time and the patient kept under observation. This is scientific urology and certainly needs no comment.

## WINFIELD SCOTT PUGH

CASE I.—M. L., white, age twenty-six, native of Poland. Present complaint: Pollakiuria, nocturnal and diurnal. Four months pregnant. Family history: No record of tuberculosis.

Previous personal: Measles and scarlatina in childhood. Rheumatism at eighteen. Several attacks of bronchitis during the past few years. One normal childbirth three years ago.

Present illness: Patient has noticed for the past two months a gradual increase in the frequency of urination. She has not bothered very much about this until the last two weeks. Since this time the frequency is day and night and quite painful. There is also slight pain at times over the right renal area, radiating down along the course of the ureter. At this point she was referred to us.

Examination shows a rather delicate looking woman apparently about four months advanced in gestation. An examination of her heart and lungs made by Dr. S. Lloyd revealed no apparent tubercular lesion. Abdominal palpation reveals aside from the pregnant uterus, a distinctly enlarged and painful kidney. Catheterized specimen of urine shows much pus, but no apparent tubercle bacilli. A complete urological examination was decided upon. The report follows:

Cystoscope enters bladder readily with but little pain. On filling the bladder considerable irritability was noticed when the viscus contained over 100 c.c. The important feature in the bladder was a slight ulceration just below the right ureteral orifice. Marked tent-like retraction was noted in the right ureter. Catheters pass readily to both pelves. Specimens taken show the following:

Right kidney	Left kidney
Color—very cloudy	Clear
Urea—trace	1¼%
P. S. P.—trace in 15 mis.	3 mis.
Pus—abundant	None
R. B. C.—a few	None
Albumin—considerable	None
T. B. C.—none	None

Guinea-pig inoculations from the right ureter were later positive.

It was considered unwise (by consultants) to do a pyelogram, as enough evidence was already available. Nephrectomy was performed with a great improvement in patient's condition and she went on to a full-term delivery.

CASE II.—Mrs. McD. (Patient of Doctor McGivern.) White, age thirty-one, native of Ireland. Present complaint: Urgency and frequency in urination, about five months' pregnant.

Family history: Mother and one brother died of a pulmonary disease probably tuberculosis. Previous personal: Bronchitis, pertussis and pneumonia during infancy.

Two previous maternities. History otherwise negative.

Present illness: Patient states that about two months ago a pollakiuria appeared at first only during the day, but that recently it also annoys her at night. Urination has become painful and urgent. Pain has appeared over the right kidney. Her physician has examined her carefully for tuberculosis of the lungs and has also had the urine examined repeatedly, and it is always negative for tubercle bacilli.

A complete urological examination was made. This revealed marked contraction of the bladder and pus coming from the right ureter. The pus contained tubercle bacilli. No response to functional test of right kidney. Pyelogram showed the typical moth-eaten kidney so often seen in renal tuberculosis. Vaginal examination revealed a markedly swollen and painful ureter on the right side. Diagnosis of renal tuberculosis. Operation of nephrectomy was performed about two weeks later. Convalescence was uneventful. Labor occurred at about eight months. The child is apparently healthy.

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CASE III.—Mrs. L. W., white, age twenty-five, native of U. S. Patient of Doctor Yacobin. Present complaint: Pain in right lumbar region and frequency of urination.

Family history: One brother said to have died in childhood of pulmonary tuberculosis.

Previous personal history: Has had the usual diseases of childhood—mumps, measles, etc. One attack of acute rheumatic fever at eighteen. Otherwise always well.

Present illness: Patient believes that her condition began about seven months ago, that is three months prior to impregnation. At first she noticed a dull ache at times over the renal area. These aches gradually increased until they became attacks of renal colic. Attacks have been much more frequent since conception and a marked pollakiuria has appeared.

The usual urological examination was carried out and the right kidney found well advanced in tuberculosis.

Treatment: We recommended that she have an immediate nephrectomy. This was not agreed to by the family or the physician to the household and as we refused anything else, the case passed out of our hands. The patient was then treated by a well-known obstetrician, who emptied the uterus. Two weeks later the patient died of a lesion said to be pneumonia.

### SUMMARY

We believe that these cases and those previously reported by others justify the claim that nephrectomy is the procedure of choice, in unilateral renal tuberculosis of pregnancy.

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# THE PATHOLOGY OF CHARCOT JOINTS\*

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CHARCOT, or neuropathic joints, present variable pathological pictures, depending upon the time of observation. Because of the painless onset, the condition is rarely seen before marked bone and joint pathology exist.



FIG. 1.—(Case I.) Charcot shoulder with sclerosis of the head of the humerus. Six weeks old fracture of the humerus.

Atrophic and hypertrophic changes in the articulating bones are described; one writer claiming atrophy, another hypertrophy as the predominating pathological change. As a result, two kinds of arthropathy have been thought to exist. It is believed that this variation depends only upon the time of observation, and that all uncomplicated Charcot joints go through a definite and similar process of change in this order: loss of protective joint sensibility; relaxation of the lateral ligaments with consequent minor marginal and major joint

fractures; destruction of the articular cartilage and the intra-articular ligaments; sclerosis of the bone ends denuded of cartilage; peri-articular and par-osteal bone production; continued erosion and fracture of the articulating ends; and finally, when the bones no longer articulate, or when invalidism occurs, atrophy. The process may stop at any point, or any of the above characteristics may predominate or be subordinated depending upon the joint involved and the extent of the nerve injury.

*Pathogenesis.*—In the light of our present knowledge the pathogenesis seems clear. The original theory of Charcot that neuro-arthropathy is due

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FIG. 2.—(Case I.) Charcot spine.

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primarily to a change in the central nervous system is still generally accepted. If the two cases of Charcot joints following peripheral nerve injury reported by Philips and Rosenheck<sup>1</sup> prove after sufficiently long observation to be such, the theory will have to be extended to include also lesions of the peripheral nerves. Any joint deprived of its sensory mechanism and subject to trauma may become a typical Charcot joint. Arthropathies have been reported following stab wounds of the back, brachial plexus injuries, transverse myelitis, spina bifida, and amyotrophic lateral sclerosis. Most of the

cases, however, are seen in tabes and syringomyelia; approximately 10 per cent. of tabetics and 25 per cent. of syringomyelitics developing typical joint changes. (Borchard<sup>2</sup>.) There is no reason why Charcot joints cannot develop as well following a peripheral sensory as a central sensory nerve lesion, provided the motor power of the member has not been involved. Eloesser<sup>3</sup> proved trauma an essential factor. He cut the posterior sensory nerve roots to one leg in a number of cats. None of the animals showed

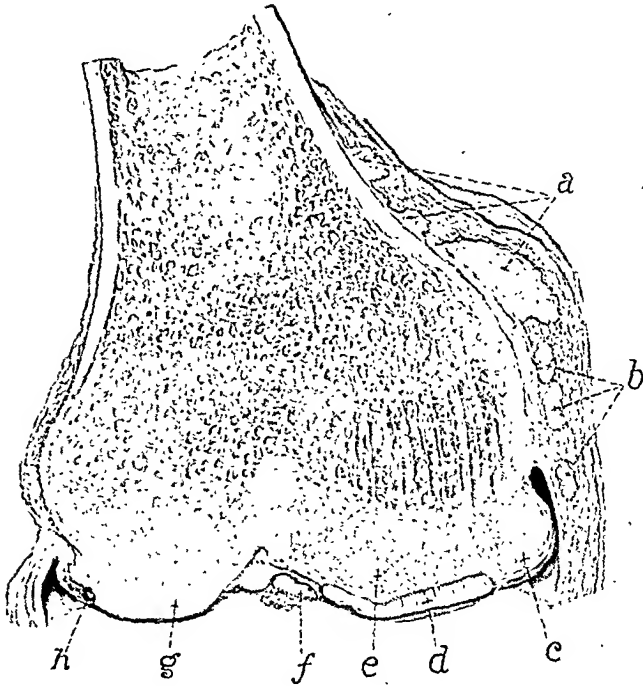


FIG. 3.—(Case II.) (a) Par-osteal bone; (b) bone plaques in the capsule; (c) peri-articular bone; (d) articular cartilage preserved; (e) normal bone; (f) remnant of cruciate ligament; (g) sclerotic bone; (h) marginal fracture.

joint changes. Trauma to the densitized joints resulted in the development of typical arthropathies in every animal experimented upon. In the course of recent experiments requiring the desensitization of a limb (work to be reported later), I cut the posterior sensory nerve roots to one hind leg in eighteen dogs. No gross joint changes followed. The body weight of the animal distributed to four extremities lessens the strain on the desensitized joint. Trauma does not occur, and arthropathies do not develop. That trauma is an essential factor is suggested by the greater frequency of tabetic joints in the pre-ataxic stage. Likely in these cases the first change is in the sensory nerves to the joint. Normal movement is not interfered with, and the joint surfaces are subjected to greater strains than in the ataxic stage.

It is believed that in a true flaccid paralysis arthropathy does not develop because one of the essential factors is missing—the necessary muscle power to manipulate the joint and bring the articulating bones into forceful apposi-



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tion. However, Mme. Dejerine<sup>4</sup> found thirty-eight instances of parosteopathopathy in fifty-eight cases of paraplegia. The authors think this condition does not occur in cases of destruction of the gray cells below the site of injury. They ascribe the new bone growth to an irritability of the nerve cells of the intermediate gray column in the segments of the dorsal cord below the injury, and to irritation from involuntary movement.

The apparent paradox of pain in an insensitive joint has caused some to question whether the sensory nerve lesion is essential. Oehlecker,<sup>5</sup> and more recently Eloesser<sup>6</sup> demonstrated by thrusting a pin through the sensitive soft tissues into the joint that its surfaces and the periosteum about the joint are insensitive. The pain caused by effusions into the joint is due to the distention of the soft tissues.

### *Gross Pathology.*—

Relaxation from tear of the lateral ligaments is the first grossly recognizable change. It is manifested clinically by an increased lateral mobility of the joint. This results in joint injury. Contusions, loosening of osteophytes, and marginal fractures, especially in the lower limbs, often with effusions, follow.

Villous formations of vascular character grow on the inner margin of the capsule and in the intercondylar spaces. If a fracture occurs through these villi, or if they are severely contused, hemorrhagic effusion results. The small detached fragments, microscopic or gross, remain in the joint or lodge in the capsule and the surrounding ligaments where they grow and form the loose bodies in the joint and the bone islands about the joint characteristic of neuro-arthritis.

Peri-articular bone formations in the early stages present a picture identical with that of hypertrophic osteo-arthritis. As the process advances these masses become larger and more irregular than in arthritis, and extend on the shaft for a cm. to 10 cm. or more. This parosteal bone is pathognomonic of a Charcot joint. It may grow into the ligaments and extend into

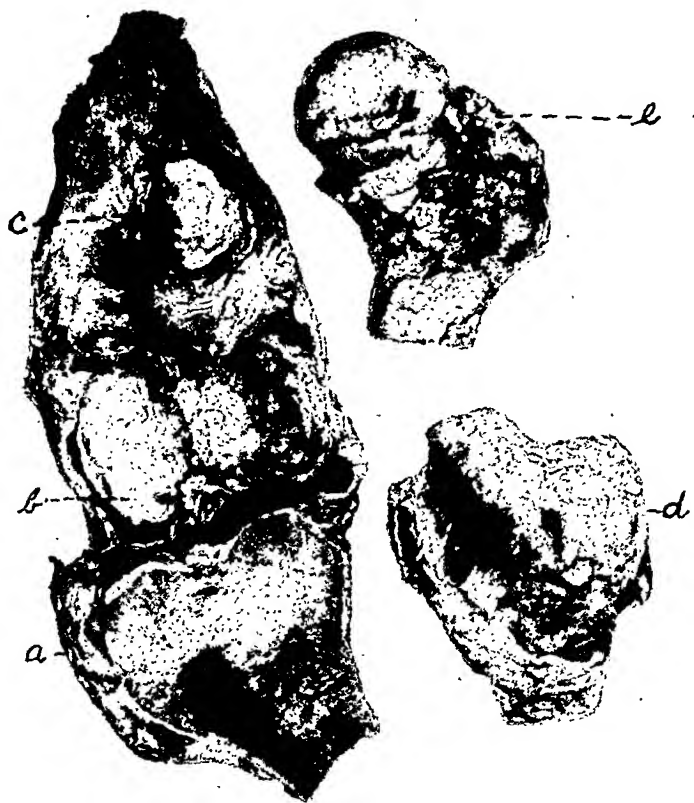


FIG. 4.—(Case II.) Charcot knee and hip. (a) Sectioned tibia; (b) condyles of the femur; (c) articulating surface of the patella; (d) anterior surface of the upper end of the tibia; (e) changes in an early Charcot hip (see text).

the muscle resembling myositis ossificans, with this difference, that myositis ossificans is rarely connected with the joint except in elbow injuries. (Machol<sup>7</sup>) The haphazard arrangement of this bone suggests that it grows in response to continued irritation.

Intra-articular destruction begins early and continues as long as the patient lives. The cruciate ligaments and the semi-lunar cartilages in the knee and the teres ligament in the hip are destroyed. The articular cartilage is slowly and painlessly worn away, usually first on the distal surface. As long as it remains intact there is no gross change in the underlying bone, but as soon as the bone is exposed sclerosis occurs. This hardening process can be observed at some time in the development of all ordinary Charcot joints. It is not a part of the disease but rather a local, protective bone reaction.

It is claimed that the shoulder and hip-joints usually show atrophic changes only. I believe they go through the same process as any other joint. Because of the construction of the hip and its great liability to fracture of the neck when densensitized, these cases usually come under observation when fracture occurs, before marked joint pathology exists, or late, when function is interfered with due to absorption of the head and to extensive joint disorganization. In the affected shoulder-joint relaxation of the ligaments allows the head of the humerus to fall far from the glenoid fossa. Atrophy from lack of articulation and lessened use follows.



FIG. 5.—(Case I.) Section from the head of the humerus. (a) Articular cartilage preserved; (b) replacement of marrow by fat; (c) articular cartilage worn away, bone sclerotic.

CASE I.—C. W., age seventy-one, with tabetic paraplegia for twenty-two years, entered the Presbyterian Hospital on Doctor Phemister's service with a recent traumatic fracture of the right humerus, and Charcot joints of the right shoulder and spine. Six weeks after placing the fractured humerus in a plaster case the patient died of pyelo-nephritis secondary to bladder incontinence and overflow. The right humerus and the entire spinal column were removed for study.

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Where the articular cartilage of the head of the humerus is worn away over an area 5 cm. in diameter, the bone is smooth and eburnated. Longitudinal section shows this sclerosis, of uniform density, to extend about 1 cm. into the bone. About the denuded area the cartilage increases from paper thickness to normal at the periphery. It is irregular, pitted, and nodular. At the margin there is lipping osteo-arthritic in character. Anterior to the intertubercular sulcus lies an area of par-osteal bone, 2 by 3 cm., and  $\frac{1}{2}$  cm. thick. (Fig. 1.)

The fractured humerus illustrates the same changes seen in the joints. There is sclerosis of the ends of the fragments, and an extensive overgrowth of cartilage. The fracture was painless, the patient very unruly, and consequently a great deal of irritation of the fragments resulted from movement in fixation appliance. Excessive callous formation in five weeks in a man seventy-one years old emphasizes the value of mobilization in callous formation. (Fig. 1.)

In the spine there is marked arthropathy between the first and second and the second and third lumbar vertebræ. The inter-articular cartilage is from 1 to 3 mm. thick, and in some areas is entirely gone. Sclerosis of the apposing surfaces is marked. Proliferative arthritis at the margins is extensive, and has resulted in bony bridging. The body of the second vertebra is slightly compressed. No loose bodies about the joint. There is no impingement on the spinal canal. (Fig. 2.)



FIG. 6A.—(Case III.) Intra-articular fracture of the medial tuberosity of the tibia.

The knee is the most common site of neuro-arthropathy. The following case is typical :

CASE II.—Mrs. R. M., age forty-three, had swelling of the right knee and painless grating in the joint for three years. She entered the Presbyterian Hospital on Doctor Gatewood's service in semi-comatose condition. A perforating ulcer of the right great toe had become infected and resulted in *septicæmia*. She died three days after admission. At autopsy the right tibia and femur were removed for study.

The changes are characteristic of a moderately advanced Charcot knee. The capsule is greatly stretched, thickened, and contains many bone plaques. Erosion of the articular cartilage of the lateral condyle of the femur due to weight bearing in an extreme valgus position has resulted in eburnation of the denuded bone. The bone

beneath the irregular but intact articular cartilage of the medial condyle shows no gross change. There is extensive peri-articular bone formation along the margin of the medial condyle. Par-osteal bone 1 cm. thick extends up the medial surface of the shaft of the femur 6 cm. (Fig. 3.)

The cruciate ligaments and the semilunar cartilages are entirely destroyed. The medial tuberosity of the tibia is on a plane 2 cm. lower than the lateral, which has been worn down. Its margin is free of cartilage, and sclerotic. In the fossa the cartilage is preserved. The upper surface of the lateral condyle with no cartilaginous covering consists of sclerotic bone. The joint surfaces of the patella show similar changes. Peri-articular bone in large masses extends irregularly from the margins of the patella and both condyles. (Fig. 4.)



FIG. 6B.—(Case III.) Same as 6A six months later. Complete separation of fragment.

Although this patient complained of no trouble in her hip, it shows the earliest changes of neuro-arthritis. The capsule is thickened. At the articular margin of the head there is lipping, jagged in places where marginal fractures have occurred. Plaques of bone from 1 to 2 mm. in diameter are attached to the neck of the femur, all within the capsule. The teres ligament is in shreds. The articular cartilage is worn down, and at the point of weight bearing over an area  $\frac{1}{2}$  cm. in diameter, is worn away. In this small area the underlying bone is already sclerotic. (Fig. 4.)

#### *Microscopic Pathology.*—The microscopic

picture is that of repair of irritated and broken tissue. The capsule consists of fibrous tissue in which at times are embedded islands of bone and cartilage. The bone is of cancellous structure; the cartilage, hyaline. Deposits of calcium salts may lie in the scar tissue about the fragments. (Kawamura.<sup>6</sup>)

The peri-articular and par-osteal bone attached to the cortex and the periosteum invades irregularly the surrounding fibrous tissue. Areas of ossifying cartilage are scattered in this bone. Lymphoid cell nests resembling bone-marrow are present where the bone is thick. In places there is ossification of the fibrous tissue replacing the tendons and muscles. (Barth.<sup>9</sup>)

The synovia is thickened. Serous or sero-hemorrhagic fluid is commonly

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found in the joint. Villous formations attached to the inner surface of the capsule and the intercondylar spaces consist of loose vascular connective tissue and fat. The walls of the vessels are thickened, and some are thrombosed. Where articulation occurs poorly the cartilage is very irregular and permeated with fibrous tissue. In the bone ends where the cartilage is not destroyed the marrow is partly replaced by fat. Areas of bone absorption occur. The haversian canals are widened. Where the cartilage is worn away



FIG. 7.—(Case IV.) Bilateral Charcot hips.

the bone is greatly increased in density. The interstices between the bone formations are small and filled with fibrous tissue. (Fig. 5.)

*X-ray Pathology.*—The röntgenographic findings are of prime importance as they illustrate the "pathology of the living."

The first deviations from normal are: increase in the joint space due to ligament relaxation and wearing down of the articular cartilage; roughening of the joint margins due to marginal fractures; and joint lipping. Occasionally, as is illustrated in the following case, an intra-articular fracture is the first evidence of neuro-arthritis.

CASE III.—J. B., age thirty-eight, came to the Central Free Dispensary complaining of a swollen, persistently painful left knee. Nine months previous while crossing the street he had twisted the knee. Immediate swelling and pain developed and persisted. He was treated as a case of mild arthritis. Examination revealed moderate swelling of

the knee, tenderness and crepitus over the medial tuberosity of the tibia, slight resistance to flexion and extension, and excessive freedom of motion laterally. The X-ray discloses a complete fracture of the internal tuberosity of the tibia; moderate peri-articular bone formation; increase of the joint space; sclerosis of the upper end of the tibia. (Fig. 6A.)

The patient refused treatment. In six months he returned with marked advance in the process, but alleviation of all pain. (Fig. 6B.)

As process advances, sclerosis of bone ends denuded of cartilage appears in X-ray. Bony islands formed from loosened fragments appear in the joint and its capsule. The peri-articular and par-osteal bone is pathognomonic of the process. As sensation in and about the joint lessens, and multiple fractures and erosions occur, complete disorganization follows, and the joint becomes literally a bag of bones. The atrophy which appears late is the atrophy of disuse.

That the sclerosis mentioned above occurs in upper extremity and hip arthropathy is illustrated in Fig. 1 and in the following cases:

CASE IV.—C. H., age forty-eight, tabetic, had had bilateral "hip trouble" requiring the aid of crutches for eight years. Seven months previous to examination by Doctor Bevan he had sustained an injury to the left elbow. Swelling, pain, and limitation of function persisted.

*X-ray Examination.*—The head, neck, and lesser trochanter of each femur is gone. The shafts are displaced upward to within one inch of the level of the anterior superior spines. In the right acetabulum there is a remnant of the head of the femur. Both femoral shafts and the acetabular region show marked atrophy. There is no par-osteal bone. (Fig. 7.)



FIG. 8.—(Case IV.) Charcot Elbow. Atrophy of non-articulating radius; sclerosis of articulating ulna.

In the elbow-joint there is destruction of the articular surfaces. Loose bodies in the joint and bony deposits in the capsule are evident. The external condyle of the humerus, the head and neck of the radius are gone. Peri-articular and par-osteal bone on the lower end of the humerus and upper end of the ulna are marked. Atrophy of the upper end of the radius which does not articulate, and sclerosis of the ulna which does articulate. (Fig. 8.)

CASE V.—F. B., age thirty, fell while attempting to board a car, and sustained an injury to his hip. Severe pain and complete loss of function resulted. When seen three days later, local examination revealed 1 cm. shortening of the thigh, and moderate tenderness in the hip on pressure and motion.

X-ray examination discloses narrowing of the joint space superiorly, widening medially; flattening of the head of the femur; sclerosis of the head and the region about

## THE PATHOLOGY OF CHARCOT JOINTS

FIG. 9.—(Case V.) Stage of sclerosis in early Charcot hip.

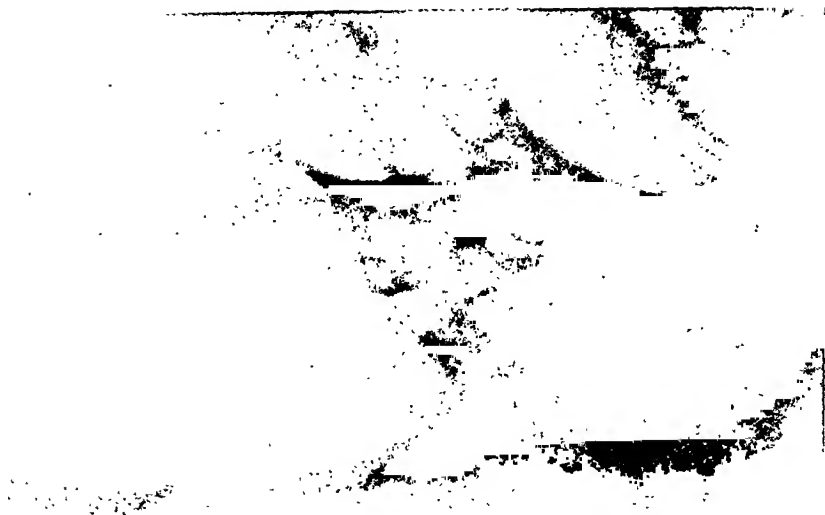


FIG. 10.—(Case VI.) Charcot shoulder in syringomyelic.



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the acetabulum; bone production and bone destruction; granular debris in the joint. (Fig. 9.)

CASE VI.—V. S., age fifty-three, laborer, with syringomyelia, presented himself with trophic ulcers of the right chest wall and an advanced right Charcot shoulder. His occupation, that of hide scraper, resulted in a great deal of irritation of the shoulder with consequent extensive overgrowth of bone. (Fig. 10.) The upper one-third of the humerus is gone but the remnant, still articulating, is sclerotic.

We have illustrated in Case IV the stage of atrophy from lack of articulation; in Cases V and VI the stage of sclerosis and hypertrophy. The elbow-joint in Case V illustrates both conditions in the same joint.

*Discussion.*—Neuro-arthropathy may affect any joint in the body. Two conditions must obtain: a change in the sensory nerves of, and trauma to, the joint. As long as the existence of trophic nerves is unproven there is no reason to believe this condition due to anything but the destruction that must follow in a joint without its protective sensory mechanism. When the bones are deprived of the accurate weight distributing power of the muscles and of the stabilizing protection afforded by an intact reflex nervous mechanism minor stresses will result in damage. So-called spontaneous fractures in tabetics are common for this reason.

On this hypothesis neuropathic joints are simply changing pictures of destruction and erosion and nature's attempt to stop the damage by sclerosis and repair the damage by building up new bone. The bizarre pictures are the result of the excessive rapidity of either process.

Modifying terms, if any, should be those descriptive of the predominating process.

This study was made at the suggestion of Doctor Phemister to whom I am indebted.

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# THE PREPARATION OF COLLOIDAL LEAD FOR THERAPEUTIC USE\*

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THE present paper presents a technic for the preparation of colloidal lead which is based upon Bredig's<sup>1</sup> method for the preparation of colloidal metals. This technic has been used in the preparation of colloidal lead intended for intravenous injection in this hospital. In Bredig's method two metal electrodes are immersed in water or some electrolyte solution. A current is then passed through the electrodes, which are held just far enough apart so that an electric arc is formed between them. The arc disintegrates the metal of the electrodes which disperses in the liquid to form a more or less stable colloid. The stability of the colloid formed depends upon the condition of the experiment and the metal used. Colloids of a number of different metals may be made in this way.

*Apparatus.*—The apparatus, illustrated in the accompanying figure (Fig. 1) consists essentially of a lead plate as anode, and an adjustable roll of lead foil as kathode. The holder for the kathode is a modification of the Columbia arcing stand described by Beans and Eastlack.<sup>2</sup> "L" is a hard rubber block carrying the contact plug "A", and the screw feed "E". From "A" connection is made through the sliding contact "C" with the brass tube "D", which may be fed down slowly by means of the screw feed "E". The whole electrode holder may be fastened to a stand by means of the clamp "G". The electrode "F" is a roll of C. P. lead foil which is inserted in the tube "D" and fastened there by means of the small screw "P".

The positive electrode is the lead plate "I", having a strip of lead leading to the top of the beaker "H", and a rounded portion of such a size as to cover the bottom of the beaker. The beaker is covered with a mica cover "M", which is perforated to admit the passage of the kathode and of the glass tube "J" and the thermometer "K". The beaker is immersed in a water bath with an outlet (not shown in the figure), so that the temperature of the sol may be kept low during arcing.

The electrodes described are connected in series with an ammeter and one or more rheostats to a 120 volt D. C. circuit. A voltmeter is connected in parallel with the arc. It is desirable that one of the resistances in the circuit should have a large self-inductance, as this aids in the maintenance of a steady arc. The lead used for the anode in this work was  $\frac{1}{16}$  of an inch commercial sheet lead from the National Lead Co. That for the kathode was "Pueblo" lead foil, silver and bismuth free, from the American Smelting

\* A complement to the paper by Stone and Craver, on The Colloid of Lead Treatment of Malignant Neoplasms in the ANNALS OF SURGERY, September, 1927.

and Refining Co. It was obtained in ribbons 8 cm. wide, weighing 1.2 gm. per linear cm. Sections of this ribbon were rolled lengthwise to form the electrode.

*Method.*—The electrolyte solution or the distilled water in which a sol is to be made is first boiled to expel the major portion of the carbon dioxide it contains. The beaker is immediately transferred to the water bath, and the anode and the mica cover are put in place. The thermometer is adjusted below the surface of the solution, and the end of the glass tube "J" just above the surface. A stream of air freed from carbon dioxide by washing with strong potassium hydroxide solution is passed through this tube and over the surface of the liquid during the entire time the apparatus is in use. A stream of cold water is allowed to flow through the water bath until the temperature of the contents of the beaker has fallen to about 40° C. After this the water is turned off and ice is added to the bath.

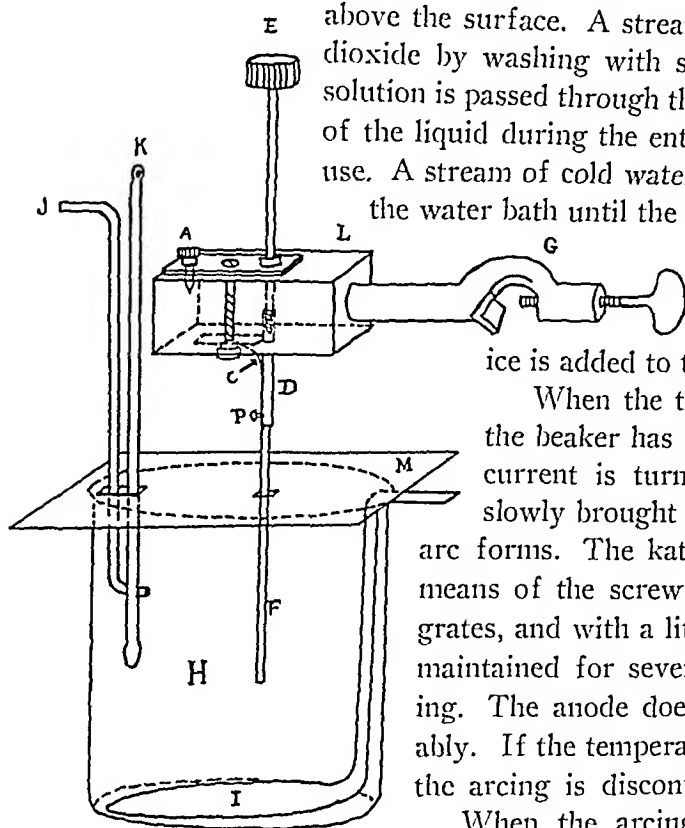


FIG. 1.

When the temperature of the liquid in the beaker has fallen to 20° C. the electric current is turned on and the kathode is slowly brought down to the anode until an arc forms. The kathode is then fed down by means of the screw feed as fast as it disintegrates, and with a little practice the arc may be maintained for several minutes without breaking. The anode does not disintegrate appreciably. If the temperature rises as high as 30° C. the arcing is discontinued until it falls again.

When the arcing has been continued for the desired total time, the circuit is broken and the lead sol is poured into 50 c.c. centrifuge tubes and covered with rubber caps. It is then centrifuged for five minutes at a velocity of 2450 R. P. M. in a centrifuge having a radius to the centre of the tubes of 15 cm. The force developed at the centre of the tubes is thus about 1000 x gravity. Samples are then withdrawn from the middle of the tubes for analysis, and melted paraffin is immediately poured over the surface of the sol so as to make a tight seal. It is important that no air bubbles be present under the seal.

The samples are analyzed by the colorimetric sulfide method this being checked occasionally against the specific gravity method of Stenstrom and Reinhard.<sup>3</sup> In the colorimetric method a 0.5 c.c. to 2.0 c.c. sample of the sol is withdrawn by means of a pipette, the volume to be taken being determined by the apparent concentration of the sol. The sample is then diluted with water, dissolved by the addition of a drop of concentrated acetic acid, and made up

## PREPARATION OF COLLOIDAL LEAD FOR THERAPEUTIC USE

to 25 c.c. in a quantitative flask. The solution is then transferred to a colorimeter cup and made slightly alkaline with ammonia. Two drops of 10 per cent. sodium sulfide are then added and the depth of color produced is compared colorimetrically with that formed in the same way from a standard lead acetate solution containing .005 per cent. lead. This method is accurate to  $\pm 1.5$  per cent. under favorable conditions, but as large errors occasionally occur, all sols intended for clinical use were analyzed in quadruplicate.

*Properties.*—Lead sols have been made by the method described with a number of different currents and electrolytes. Currents of 1.4 amp., 2.0 amps., 3.8 amps., and 7.0 amps, have been used. The electrolytes studied were .00025M HCl, .00125M  $\text{H}_2\text{SO}_4$ , .00022M acetic acid, .00025M NaCl, .000125M  $\text{NaHCO}_3$ , .000125M  $\text{Na}_2\text{CO}_3$ , .00011M KOH, .00022M KOH, and .00044M KOH. These solutions were all made up in water redistilled from permanganate solutions through a block tin condenser, and having a pH range of 5.2 to 6.0, with an average of 5.8. Lead sols were also made by arcing in distilled water to which no electrolyte had been added. There are not yet sufficient data to warrant definite conclusions regarding the properties of lead sols under these different conditions. In general, however, it may be said that the formation of colloidal lead sufficiently stable to withstand five minutes centrifuging with a force of 1000 x gravity is favored by a moderate (.00025M) electrolyte concentration and a high initial pH value of the solution in which the arcing takes place. The ions present also appear to exert a specific influence. Raising the amperage increases the concentration of the colloid produced, but also increases the technical difficulties. Sols made at 15°–25°C. are more concentrated than those made at 40°–50°C.

After arcing is begun in an electrolyte solution the concentration rises rapidly to a maximum which is reached after 1–1½ gms. of lead have been disintegrated per 100 c.c. of sol formed. After this the concentration of colloid which is stable to five minutes centrifuging at 1000 x gravity remains about the same even after prolonged arcing.

If the colloidal lead prepared under any of the conditions described is left exposed to the air it immediately begins to develop an area of clear supernatant liquid which increases rapidly. If the surface of the sol is large compared to its volume the entire sol may settle out in a few hours or days. If, however, the colloid is covered with a tight layer of paraffin as soon as it is made, the clear area does not develop, and the sol may be kept for from four to ten weeks with little change in concentration. Colloids so sealed have withstood six days' transportation by mail without differing appreciably from controls kept in the laboratory. It is important that air be excluded entirely, however, as 1 to 3 minutes vigorous shaking with air was sufficient to precipitate every sol so shaken. Shaking with carbon dioxide results in more rapid and complete precipitation than shaking with air.

As a result of the above observations the following technic was adopted for the preparation of colloidal lead intended for clinical use. An .088M solution of potassium hydroxide which had been standardized by titration

against a standard acid was diluted with distilled water to .00022M as required. The sols were made with aseptic precautions in this KOH solution with a current of 1.4 amps., the potential drop between the electrodes averaging 40 volts during arcing. The arcing was continued until  $1\frac{1}{2}$  gms. of lead had been disintegrated from the kathode per 100 c.c. of sol formed, the temperature being kept between  $15^{\circ}$  and  $25^{\circ}\text{C}$ . by means of the ice bath. When the required weight of lead had been disintegrated, the sol was centrifuged, sampled for analysis, and sealed immediately with paraffin. Sols so prepared had an average concentration after being centrifuged for five minutes with a force of 1000 x gravity of .130 per cent. lead, with an average deviation of  $\pm 11$  per cent. of this value. They would keep for four weeks without coagulation or very great decrease in concentration, and withstood six days' transportation by mail. As the rate of decrease of concentration of sols which were standing quietly varied somewhat about an average value of 7 per cent. per week, sols which were kept as much as a week before use were reanalyzed. Care was taken not to include the sediment from centrifuging in portions of the sols which were intended for analysis or clinical use. There was little danger of this, however, as the sediment formed a very firm film on the bottoms of the centrifuge tubes. Sols ranging in age from two hours to nine days have been used for intravenous injection.

The sols could not be sterilized by boiling, as they precipitated when boiled. Hence those intended for clinical use were prepared with aseptic precautions. A series of six cultures from sols so prepared all proved to be negative. The colloidal lead itself appeared to possess some bacteriocidal properties, since of six cultures made from sols prepared with no aseptic precautions, only one was positive.†

These lead sols differ from those described by Blair Bell<sup>4</sup> in being less concentrated, and in containing no gelatine or other protecting agent.

*Summary.*—An apparatus is described which is suitable for the preparation of colloidal lead by the Bredig method.

Colloidal lead has been prepared under a number of different conditions. Directions are given for the preparation of colloidal lead which is suitable for clinical use, and which is stable for several weeks.

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- <sup>3</sup> Stenstrom and Reinhard: *J. Bio. Chem.*, vol. lxi, No. 2, p. 607.
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† The author is indebted to Mr. E. B. Ellis of the Pathological Laboratory of this hospital for all bacteriological work.

# TRANSACTIONS

## OF THE

### NEW YORK SURGICAL SOCIETY

*Stated Meeting Held April 27, 1927*

The Vice-president, DR. FRANK S. MATHEWS, in the Chair

#### ACUTE SUPPURATIVE APPENDICITIS COMPLICATIONS

DR. WALTER A. SHERWOOD presented a boy, nine years of age, to illustrate some of the various serious infective complications that may occur in the course of convalescence from suppurative appendicitis.

He was admitted to the Brooklyn Hospital, August 9, 1926, with the history and typical physical signs of acute appendiceal infection of five days' duration. There was a mass in the right iliac fossa, which indicated abscess formation. He was promptly taken to the operating room and the appendix removed through a right rectus incision. The organ was gangrenous. There was some free pus in right iliac fossa, and the organ was buried in a mass of dense omental adhesions. The appendix was ligated and removed without difficulty. A soft rubber tube was introduced into the pelvis. The patient made a good recovery from the operation.

There was nothing unusual about his convalescence until ten days later, when he complained of cramp-like pain in the lower left side of the abdomen. Temperature and pulse rate became elevated; there was an increased leucocytosis and abdominal and rectal examination indicated abscess formation low down on the left side of the pelvis.

On August 21, 1926, through a left rectus incision, the coils of intestine were found matted together. There was evidence of a localized peritonitis and in the depths of the pelvis a large abscess cavity was entered. A soft rubber drainage tube was placed in the pelvis and the remainder of the wound closed.

The patient convalesced normally for the following two weeks, when he developed pain and tenderness in the upper right quadrant of the abdomen. Temperature and pulse rate again became elevated, and there was every evidence of abscess formation in the sub-hepatic space. On the 18th of September, an incision was made just below the free border of the ribs. The peritoneal cavity was opened and a large abscess was found in the sub-hepatic space, from which about eight ounces of foul-smelling pus were evacuated. It might be mentioned here, that previous bacterial examination at the time of the original operation, revealed a long chain streptococcus. A soft rubber drainage tube was inserted in the abscess cavity, and wound closed in the usual manner.

From this time on, his convalescence was uninterrupted. All wounds healed kindly, and he was discharged from the hospital on October 14, 1926, two months after his admission.

Four days later he was again admitted to the hospital with all of the symptoms of acute high intestinal obstruction. His symptoms were cramp-like pain—generalized—over the abdomen, continuous vomiting, and obsti-

nate constipation. When admitted, his abdomen was somewhat distended. There was marked tenderness in the left upper quadrant and visible peristalsis. No masses were found and there was but slight muscular rigidity. A definite diagnosis of obstruction was made. He was again taken to the operating room and through a left upper rectus incision, a distended colon presented itself in the wound. Further examination revealed a collapsed ileum, and on following this, a definite firm band of peritoneal adhesions was found binding the ileum down in the pelvis. Above this band, the ileum was enormously distended. The band was divided, after which the distended coil collapsed, and the collapsed coil dilated. No other pathology was found, except the evidence of previous peritonitis, and the wound was closed in the usual manner without drainage.

Since this time, the patient's recovery has been without interruption, and he is now in perfect health.

DR. SEWARD ERDMAN said that all surgeons have seen many interesting variations in the complications of appendicitis and he thought that it might be of value at this time to refer again to a method of draining the residual pelvic abscess which he knew was not looked upon with entire approval by surgeons in general. In Doctor Erdman's own experience drainage through the rectum has been done in twelve to fifteen cases with entirely satisfactory results, especially in males, in which cul-de-sac drainage is impossible. It is very simple, does not produce shock, does not require opening the peritoneal cavity, does not increase the possibility of later adhesions, and often tides over the danger period for the patient who is rapidly going down hill. There is no abdominal wound to heal, and the patient may be allowed out of bed promptly. There can be no question but that this is a really valuable procedure in appropriate cases.

#### PERFORATING ULCER OF THE STOMACH INVOLVING PANCREAS

DR. WALTER A. SHERWOOD presented a colored man, fifty-six years of age, who entered the Brooklyn Hospital, September 10, 1926. His chief complaints were abdominal pain, indigestion, intermittent vomiting and constipation. He gave a history of "stomach trouble" extending over a period of many years. He belched large quantities of gas and had occasional attacks of vomiting. Two years previous to admission, he had a severe attack of pain in the right lower abdominal quadrant, which was relieved by ice and supposed to have been an attack of appendicitis.

His present illness began ten days previous to entering the hospital, at which time he had a cramp-like pain in the right lower quadrant. He vomited, and continued to vomit every day thereafter. He had lost considerable weight, but attributed this to lack of nourishment. On the day of admission he had a gastric hemorrhage of bright blood, mixed apparently with old clotted blood. The hemorrhage was moderately severe and resulted in an elevated pulse rate and a considerable degree of anæmia.

The patient was kept under observation for a period of three weeks, during which time a study of his condition revealed the following: Age, general appearance and loss of weight, were suggestive of malignancy. An X-ray examination of the gastro-intestinal tract revealed a large protrusion on the lesser curvature of the stomach, which was characteristic of a per-

## RESULT OF OPERATION FOR RHINOPHYMA

“ perforating ulcer. This was a constant finding, and the extent of the involved area further suggested malignancy. Both stomach and bowel contents contained blood. He had a low gastric acidity, both hydrochloric and free acid. His hæmoglobin ranged between 45 per cent. and 68 per cent. The provisional diagnosis was perforating gastric ulcer of the lesser curvature with malignant degeneration.

October 4, after a preliminary blood transfusion, the abdomen was opened through a long right rectus incision. On the posterior wall of the lesser curvature of the stomach, there was a large chronic, indurated ulcer with a definite crater, which easily admitted the tip of the first finger. This was found to have perforated the posterior wall of the stomach into the substance of the body of the pancreas, where there was a large indurated area of approximately the size of a hen's egg. It was difficult to determine whether the condition presented was malignant or benign. A piece of tissue and an enlarged lymph-gland were removed from the gastrohepatic omentum for immediate frozen section, and the pathologist reported that there was no evidence of malignancy. The appendix was adherent in the pelvis and showed definite evidence of previous attacks of infection. There was also a perimembranous colitis, which, in one place, angulated the cæcum. The character and location of the ulcer did not lend itself well to resection.

The following procedure was carried out: (1st) Gastrotomy, with a linear opening on the anterior wall of the stomach. Good exposure of the ulcer was obtained, and its base, edges and bottom of the crater were thoroughly destroyed with the actual cautery. The wound in the stomach was closed with two continuous rows of chromic catgut sutures. (2nd) A posterior no-loop gastrojejunostomy was done with Roosevelt clamp, and the usual three layers of continuous chromic gut sutures. (3rd) Appendectomy. (4th) Release of angulation of cæcum by dividing the band of Jackson's membrane, which extensively covered it and appeared to interfere with its normal contour and function. The wound was closed in the usual manner without drainage.

The patient made a very satisfactory recovery and has been followed at regular intervals from time to time. He is entirely free from symptoms; has gained forty-three pounds in weight, and feels perfectly well in every respect.

This patient is presented to illustrate the following points:

1. The relation between certain types of appendiceal infection and gastric or duodenal ulcer.
2. The value of immediate frozen section as an aid in establishing the differential diagnosis between malignant and benign lesions of the stomach.
3. The value of so-called Balfour cautery operation, plus gastro-enterostomy in certain types of gastric ulcer, in which the location and extent of the ulcer do not lend themselves well to more radical operation. This particular operation has proved very satisfactory in a number of instances in our hands.

## RESULT OF OPERATION FOR RHINOPHYMA

DR. WALTER A. SHERWOOD showed lantern slides taken of a man, seventy-two years of age, who for eight years had had a steadily increasing enlargement of the nose, which had recently increased to such proportions as to be a matter of great embarrassment to him. Over the lower half of the nose there was a large purplish-red lobulated growth of hypertrophied sebaceous glands, which hung down over the end of the nose and partially

obstructed the nares. Its appearance was typical of an extreme stage of acne rosacea, or what is commonly known as rhinophyma.

January 22 of this year, under local infiltration anaesthesia with novocain, he was subjected to a plastic operation with removal of the hypertrophied tissue from the bridge of the nose down to the end, including a thin strip of cartilage of the alæ nasi. Hemorrhage was profuse, but this was controlled by pressure and heat, after which the entire area was covered with Thiersch skin grafts taken from the anterior surface of the left upper arm. The grafts were protected by a layer of silver foil and no other dressing was applied. At the end of ten days, the dried secretion was removed and all grafts were found to have taken. The appearance of the nose rapidly improved.

The patient is presented to show the result, which may be expected in advanced cases of this condition. The pathologist reported the removed tissue to be chronic inflammatory in character, with adenoma and cystic degeneration of the sebaceous glands. This is the third patient in whom a similar procedure has been followed by him with very gratifying cosmetic results in all.

#### DISARTICULATION AT THE HIP-JOINT FOR SARCOMA OF LOWER END OF FEMUR

DR. WALTER A. SHERWOOD presented a woman, forty years of age, who entered the Brooklyn Hospital, February 22 of this year, complaining of pain and swelling in the left knee of five months' duration. While getting into bed several months previously, she noticed a small lump on the back of the left knee. This gradually increased in size, with increasing flexion deformity. Walking had been difficult for the last two months. Swelling became painful about three weeks before admission, the pain radiating downward to ankle and foot. She remained in bed for a week and swelling subsided somewhat. She had lost ten pounds in weight before operation.

*Physical examination* was negative, with the exception of the local condition. At the left knee, filling the popliteal space and extending more to the lateral surface than to the medial there is a firm, fixed and moderately tender swelling. This mass extends longitudinally for 13 cm. and the circumference of the knee-joint at the point of maximum size was 39 cm. as compared with 29 cm. on the other side. In the inguinal region on the left side, there was a large palpable lymph-node about 1.5 x 2 cm. in size—movable and non-tender.

*X-ray study* made on February 1, 1927, showed a good-sized, well-defined rarefied area in the lower end of the left femur, just above the condyle. It was centrally situated, destroying the cortex, not expanding the bone, but there was slight periosteal reaction and thickening. The process had extended into the soft parts posteriorly and to the outer side and in soft parts, bony substance was seen. X-ray diagnosis—sarcoma of the left femur—osteolytic and osteogenetic. Radiographic examination of lungs and pleura for metastases, negative.

Patient had 85 per cent. of hæmoglobin and 5,620,000 erythrocytes. Coagulation time, 4½ minutes.

Clinically, this patient seemed to be an undoubted case of osteogenetic sarcoma, and while the eventual outlook for life was not good, the general opinion was expressed that in the absence of any evidence of metastases, she



## ANEURISM OF FEMORAL ARTERY

was entitled to the benefit of radical measures, rather than to allow her to go on with nothing more than palliative treatment.

It was decided to do a high amputation and disarticulation of the hip-joint. February 24, under gas and ether anæsthesia, the common femoral artery was ligated as it emerged from beneath Poupart's ligament. This effectively controlled bleeding during operation, and was much more satisfactory than the use of Wyeth's pins or other constricting measures to control hemorrhage. With a racket-shaped incision, the joint was disarticulated and the limb removed. Muscle planes were sutured with chromic gut. Cigarette drain was introduced at either angle of the wound.

*Present Condition.*—Wound has entirely healed and general condition is gradually improving. Patient gets around fairly well on crutches.

*Pathology.*—This specimen has been studied, both in the gross and microscopically, by four pathologists. There seems to be a difference in opinion as to the exact histological nature of the tumor. The pathologist at the Brooklyn Hospital believes it to be a benign giant-cell osteosarcoma of the epulis type. Dr. James Ewing, who has also been interested in a study of this specimen, expressed the opinion that the growth was malignant telangiectatic osteogenetic sarcoma. He believes that the prognosis is bad, and states there was a difference of opinion in his own laboratory as to the true nature of this tumor.

It might also be stated that the lymph-glands removed did not show any evidence of metastases.

DR. CONSTANTINE J. MACGUIRE thought that the lack of trabeculation in the cavity spoke against the diagnosis of benign giant-cell sarcoma. He mentioned a case of supposed benign giant-cell sarcoma in Bellevue on which high amputation was done and the man died two years later with metastases in both lungs. One lung showed the microscopic picture of many giant cells, the only case the speaker had ever seen where lung metastasis contained giant cells.

## ANEURISM OF FEMORAL ARTERY. ENDOANEURISMORRHAPHY

DR. JOHN E. JENNINGS presented a man, fifty-three years of age. Luetic infection thirty years ago when he was treated for eight weeks, none since. Eight months ago patient had an attack of pain in the right leg which was relieved by heat. Three months ago he noticed a small swelling in the inner and posterior portion of the right thigh about five inches above the knee which occasionally became painful. One month ago the swelling was the size of a silver dollar, since then it has been growing rapidly and now is the size of a small grape-fruit. Is occasionally painful.

Pulsating mass in the lower fourth of the right thigh presenting on the inner and posterior aspects, bruit and thrill.

Incision along the inner border of the sartorius over tumor eight inches long. The femoral artery was isolated above the aneurism, a Crile clamp set and the aneurism opened. Sharp hemorrhage from the lower opening plugged with finger. Two other openings of arteries about two inches apart were found on the posterior wall of a fusiform aneurism involving the lower femoral and in part of the popliteal artery. The openings were plugged with absorbent cotton pledgets wet with saline and tied to silk ligatures and an 18 F. catheter was placed along the posterior wall from one opening to the other and the wall sutured over it, forming a new channel after the

method of Matas. The tube was then removed and the sutures closed. Over this a layer of interrupted sutures. The clamp was then removed from the femoral, one point of oozing found in the suture line and closed by suture. Pulsation felt in the new-formed vessel and below it. Sartorius laid over sutured vessel. Skin closed with interrupted sutures and a plaster case applied. Primary union and the pulsation of the posterior tibial persists.

### CHRONIC EMPYEMA

DR. JOHN E. JENNINGS presented a young man of nineteen years seen December 11, 1919, with a diagnosis of collapsed left lung; chronic empyema;

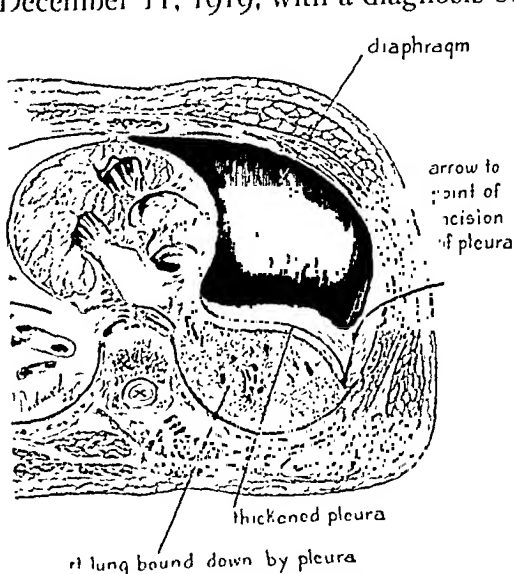


FIG. 1.—Cavity within chest.

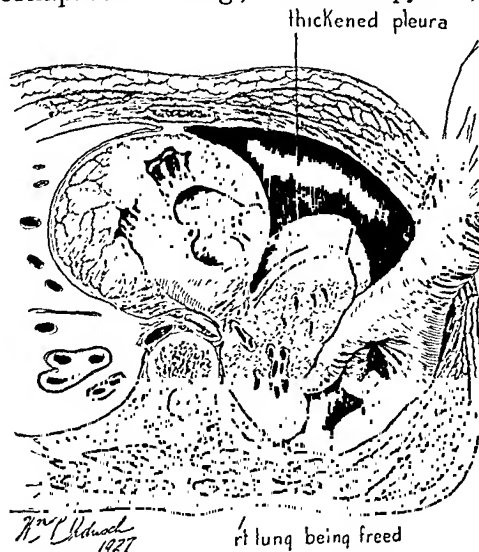


FIG. 2.—Freeing lung from confining false membrane.

phthisis dating back from March 8, 1918. He had been tapped several times in that period and operated upon on April 9, 1918. Has been draining ever since that time. He was sent into the Brooklyn Hospital, December 12, 1919, and operated upon under nitrous oxide and ether on December 15, 1919. Portions of ninth, eighth and seventh ribs removed. Two large drainage tubes inserted. January 5, 1920, he was taken again to the operating room and submitted to the first stage of a decortication. Lung stripped from its bed to a point beyond the aorta allowing lung to roll forward. Section of pleura downward in vertical direction from the transverse incision, freed the heart. Considerable expansion of lung noted. Patient did well and was discharged on January 23, 1919. On March 29 was admitted to the hospital again, having gained twenty pounds in the interim. On March 31, 1919, he was again operated upon for the second stage. Lung was discovered lying behind a dense layer of false membrane. This was stripped

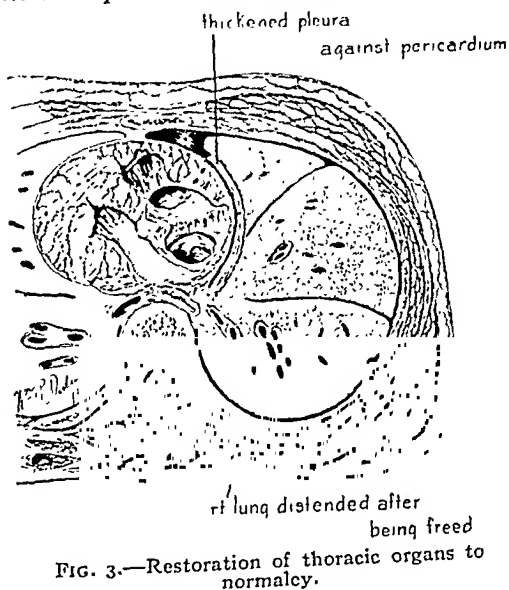


FIG. 3.—Restoration of thoracic organs to normalcy.

covered lying behind a dense layer of false membrane. This was stripped

FIG. 4.—Thoracotomy: The skin flap formed.

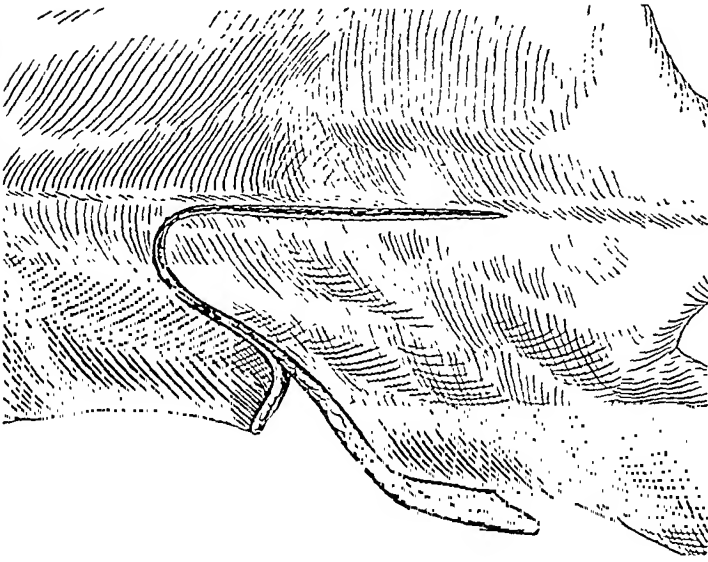


FIG. 5.—Thoracotomy: The skin flap raised.

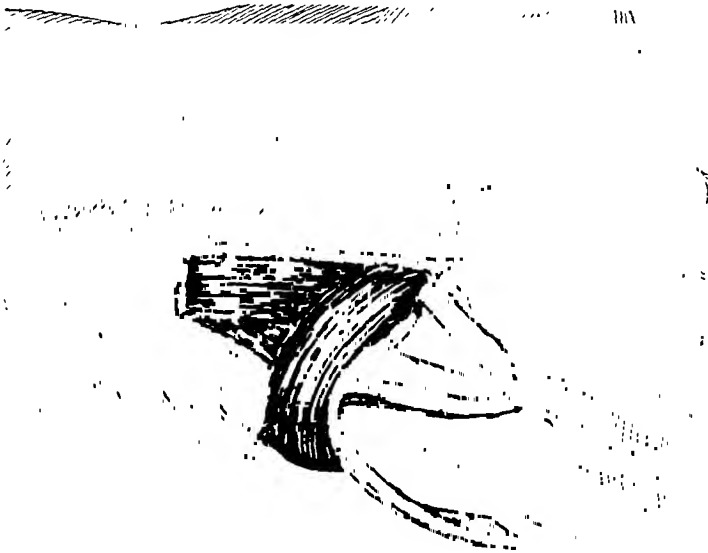
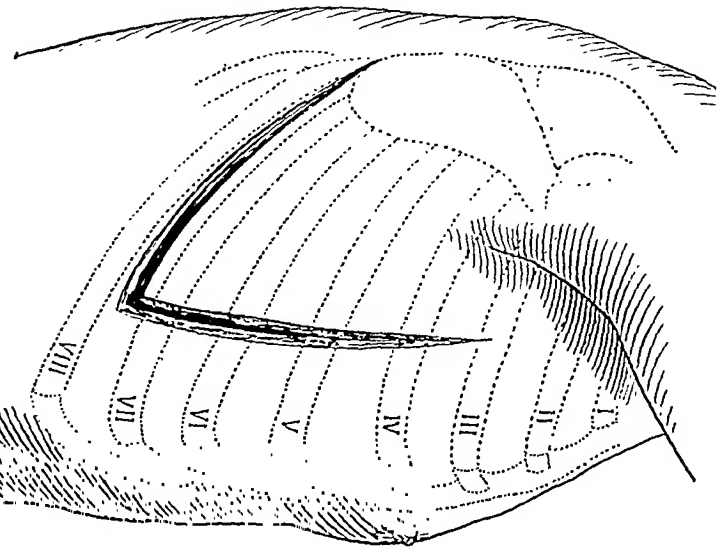


FIG. 6.—Thoracotomy: The bony section.



off the lung at a point about opposite the interlobular fissure. Lower lobe first dissected as far back as, and beyond the aorta and brought forward. Upper lobe was also freed and false membrane was removed well beyond its adherence to the lung. (Figs. 1, 2, 3.) Flap of chest wall underlying scapula mobilized and allowed to drop back, secured by sutures of heavy catgut. Portions of the sixth, seventh, eighth, ninth, tenth ribs removed low down, allowing pouch at the bottom of the cavity to collapse. Rubber drainage tube. Did very well and was discharged on May 4, 1920, with small sinus still present, very little discharge. Good expansion of lung.

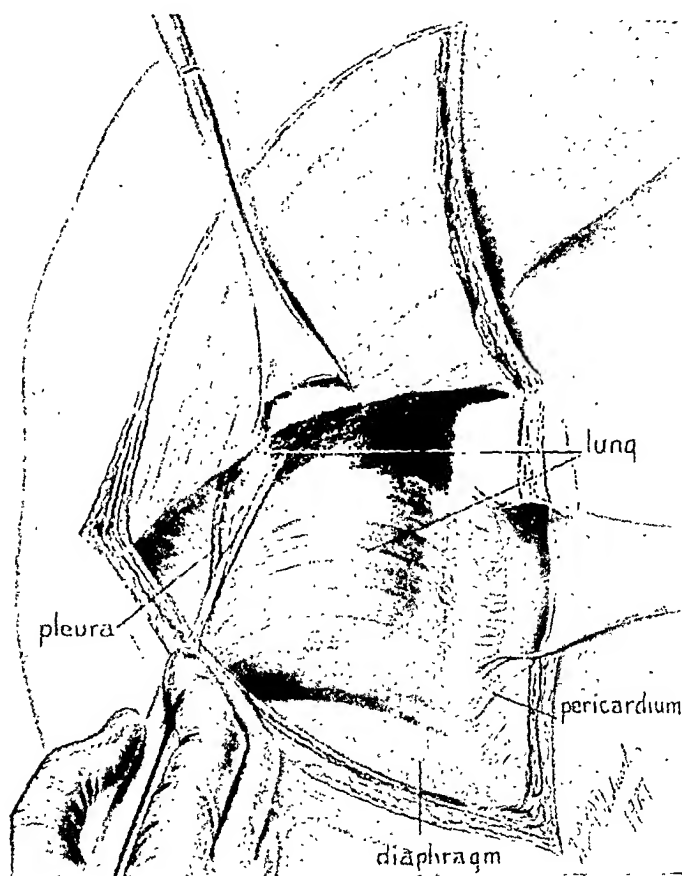


FIG. 7.—Thoracotomy: The binding false membrane exposed.

He did very well for quite some time after this. The sinus opened and closed. When closed he had sweats, expectoration of pus and blood and fever. Relieved when it opened again. Lost about eight pounds and quite a good deal of his color. Sent back to the Brooklyn Hospital for investigation and operation if necessary. Admitted on June 2, 1921, and again operated upon June 13, 1921. Incision behind left scapula disclosing sinus surrounded by new-formed bone. Portions of sixth, seventh and eighth ribs removed with new-formed bone, revealing large cavity within

chest, extending from third rib down to lower limit of cavity. Small bronchial fistula in lower portion of cavity, further removal of ribs so as to allow drainage of lower portion of cavity. No sutures. Left the hospital again on August 4, 1921, with fistula still not closed. To return later, which he did on January 8, 1922. Incision made around old sinus with removal of old rib formation making an opening six inches long through chest wall, revealing cavity about eight inches long and three-quarters inch in depth at the bottom of which a small bronchial fistula could be seen. Suture set about the orifice of fistula. Zinc oxide gauze pack. Discharged January 29, 1922, with a rather large wound discharging moderately. He finally closed up and is now well, although still quite slender.

The other case is a fireman, forty-one years of age. First seen October 7, 1919. He had a pneumonia in March, 1918, and an empyema. Was operated on in April, 1918. His side was drained with two tubes for two weeks and then with one tube for five weeks. It closed on the 24th of

## CHRONIC EMPYEMA

June, 1918, but soon opened again. He was again operated upon on September 4 and drained for four months. Then he went to Bellevue where bismuth paste was injected and it closed again in January, 1919, but in March, 1919, it opened once more and had been draining steadily since. He was admitted to the Brooklyn Hospital on October 4, 1919, and the next day an excision of the old scar and sinus and an exposure of a very large and thick-walled cavity was made with decortication. The expansion of the lung and obliteration of the cavity was prompt and satisfactory and he left the hospital on November 11, 1919, in good condition. He had no trouble for twenty months, when an abscess formed in the scar and broke down. A sinus was followed to a rib sequestrum, which was removed, and his sinus quickly closed and has remained so.

In both these cases as in three others in which the operation was performed, the lung lay completely collapsed along the spine covered by a thick pleura.

They presented, each of them, a story of more than two years' continuous and inadequate drainage.

The same procedure was followed in both these cases—a wide flap opening of the thorax, an incision along the outer edge, finding the lung. Dissection between the buried lung and the thoracic wall, leaving untouched the pleura covering the lung in front. This is essentially the procedure of DeLorme as described by him save that he cut through the pleura in front of the lung, stripping it back as well as lifting the lung. (Figs. 4, 5, 6, 7, 8 and 9.)

Fowler's description and this practice, as I knew it, was limited to clearing the face of the lung. This is not in my experience as important as is the freeing of the lung from its bed.

In late cases it is also dangerous. The adhesions between the pyogenic membrane, so called, and the pleura-covered lung, are dense and in old cases it is almost impossible to strip the lung in this way without wounding it. Especially true is this in the neigh-

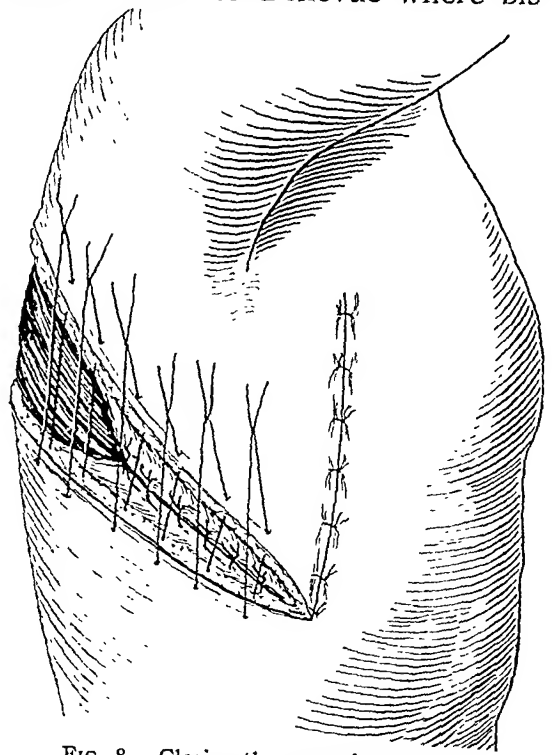


FIG. 8.—Closing the operation wound.

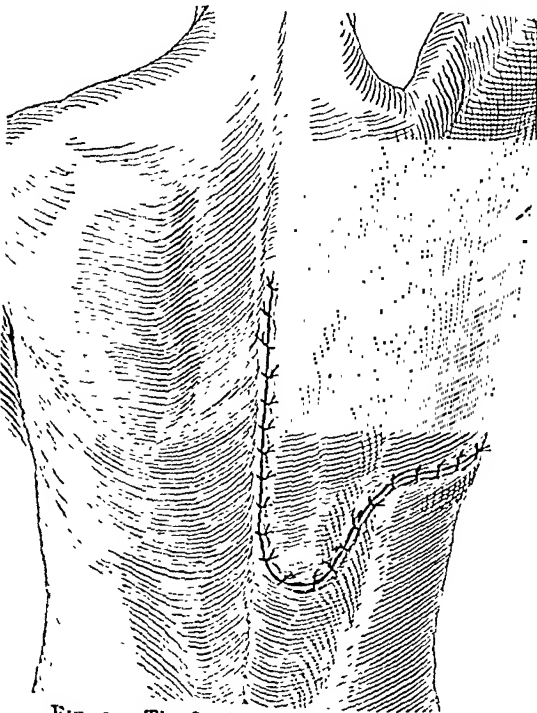
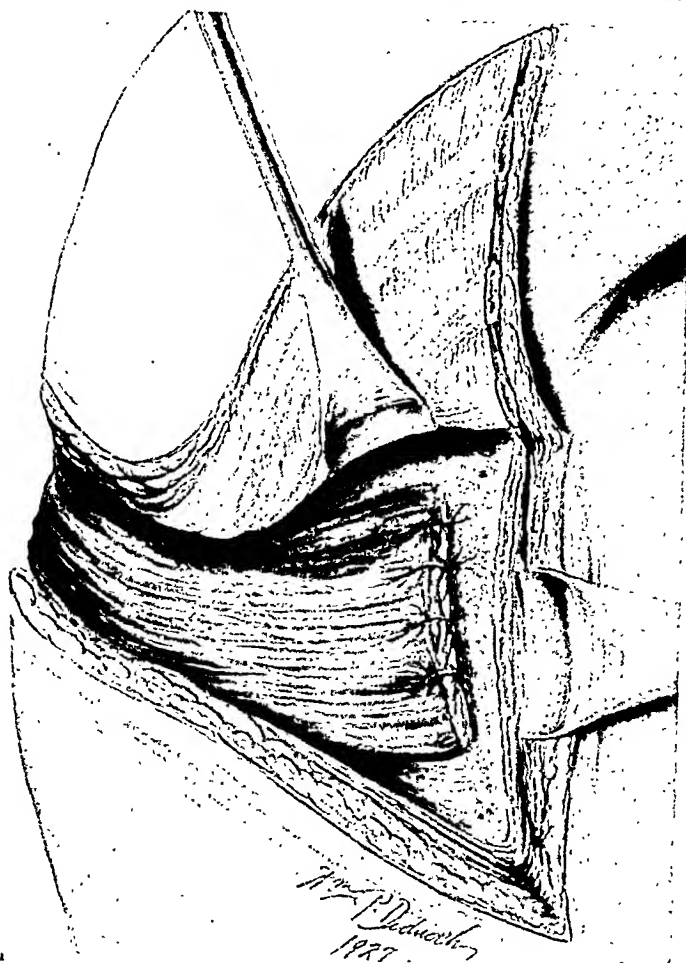


FIG. 9.—The final line of external suture.

borhood of the diaphragm. Behind the lung, on the other hand, there is adhesion, it is true, but one between two serous surfaces, parietal and visceral pleura, it is easier to free the lung without damage.

In the second case this was accomplished with success. In the first the lung was torn, a fistula developed and final closure was accomplished only after a transplant of muscle tissue had been used to fill the cavity. (Fig. 10.)



# THROMBO-ANGIITIS OBLITERANS. SYM- PATHECTOMY

DR. JOHN E. JENNINGS presented a man, aged forty-four, who was admitted into the Brooklyn Hospital, February 21, 1923, with throbbing pain in right foot with swelling, redness and scaling at the end of second and third toes, for seven weeks.

Had an operation nine years before when a piece of bone was removed from great toe following severe swelling and discoloration of foot coming on suddenly without apparent cause. In bed nine months at this time.

FIG. 10.—Transplant of muscle to fill persistent intrathoracic cavity.

March 16 he was operated upon by an incision eight inches long along inner one-third of thigh over sartorius. Sartorius muscle retracted to the outer side, revealing Hunter's canal. Canal opened, vessels exposed, femoral artery separated, tape-loop retractor. Sympathetic plexus incised, eye spud inserted underneath. Sympathetic layer cut with fine knife, using spud as director. Lid retractor slipped between artery and freed sympathetic plexus. Plexus stripped for distance of two and seven-eighths inches. One vessel in middle denuded area clamped and tied. Small vessels at either end of area clamped and tied. Sartorius replaced with plain catgut sutures. Silkworm gut to skin. Second and third toes removed. Amputated at middle metatarsal joint. Long plantar flap. Hemorrhage scanty. Chromic catgut sutures. Iodoform pack.

Second operation—April 18, 1923, under ether anesthesia. Nine-inch incision made from a point four inches above the knee on the inner surface upward and outward to a point eight inches below the anterior superior iliac spine in the midline. The sartorius was lifted from its bed and retracted inward. Hunter's canal was opened and the femoral artery dissected out for

## LUDWIG'S ANGINA

a distance of three inches. A small muscular branch was tied one-quarter of an inch from the main trunk. The adventitia was opened, split and skinned away for a distance of three inches. Interrupted chromic sutures were used to close the fascia. Similar sutures were used to close the skin.

*Laboratory Report.*—Thrombus arteritis obliterans (late stage).

He was discharged from the hospital on May 18, 1923. On October 17, 1923, he came in for final check up. Pain and soreness ceased entirely about September 1, 1923. Foot is now quite healed and perfectly comfortable.

It has been generally agreed that the operation of Leriche—peri-arterial sympathectomy—would be useless in cases of Buerger's disease. Leriche himself says in his book just published, "I have never treated a case and speak without experience."

The speaker had performed the operation as he understood it on six cases of actual gangrenous processes involving the toes. In five, the gangrene has been and remains arrested. In one it continued to spread and amputation below the knee was performed. In two, arrest of pain and complete restoration of function took place. In one, slow healing and slow but steady improvement with attacks of pain growing less. In two, slow healing but some relief from pain.

DR. FREDERIC W. BANCROFT said that in Baltimore recently, Dr. Dean Lewis showed three cases of thrombo-angiitis obliterans, in which he had ligated the femoral artery immediately below the origin of the profunda branch; he excised about three inches of the artery.

Doctor Lewis bases his principle for this procedure—(1) When gangrene of the leg does occur, it is due to thrombosis of the popliteal artery, and if the blood supply is cut off before this occurs gangrene may be prevented. (2) Injected specimens of legs amputated for this condition show marked compensatory circulation and will therefore stand very well the shutting off of the blood stream of the femoral artery.

His patients were free from pain, one year post-operative, and there was no evidence of gangrene.

## LUDWIG'S ANGINA

DR. JOHN E. JENNINGS presented two cases of Ludwig's angina. The first, a case of somewhat slow development of the disease, started March 12, 1917, with a right-sided tonsillitis which formed a peri-tonsillar swelling. Incised on the third day—no pus and no relief. Again incised the next day as the swelling was increasing—no pus and no relief. Then a hard mass developed on the right side near the angle of the jaw and he began to have some difficulty in breathing and swallowing. On the fifth day about one dram of pus appeared in the tonsil incision. There was no relief in swallowing or in breathing. Then the submaxillary mass increased in size. An incision was made. Still no relief. On the seventh day the swelling extended to the floor of the mouth and across to the left side. On admission to the Brooklyn Hospital on April 2 the floor of the mouth was œdematous and swollen, the tongue lifted high. An incision was made under the jaw on the right side and two rubber drainage tubes inserted, one to the angle of the jaw and the other below the tongue. He was discharged on the 8th of April from the hospital and was all healed on the 23rd of April.

The other case was a woman of about fifty years of age. Admitted

to the Brooklyn Hospital on January 12, 1923. Five days before admission had a severe sore throat with tonsillitis with false membrane which was suspected of being diphtheritic. The culture, however, was negative. Twenty-four hours before admission the floor of the mouth and the tongue became greatly swollen, the swelling extending from the left side with intense pain. On admission the floor of the mouth was greatly swollen and oedematous, having risen to the level of the lower teeth. The tongue enormously thickened and filling the oral cavity. Swallowing was quite impossible and dyspnoea beginning to be pronounced. On January 12 under

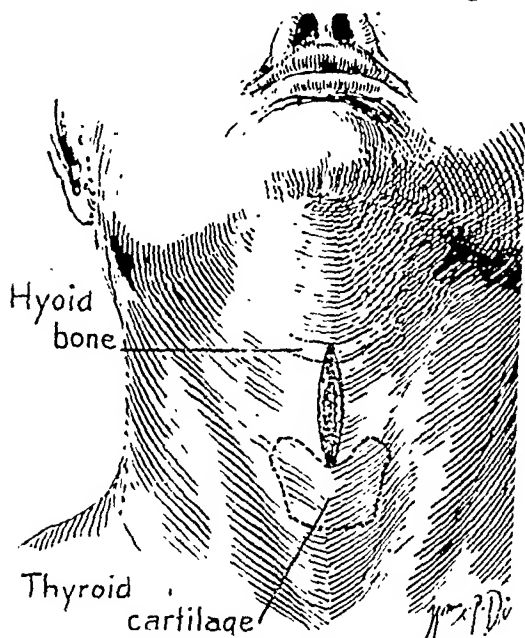


FIG. 11.—Incision for Ludwig's angina.

chloroform anaesthesia an incision made in the midline of the neck between the tip of the chin and the hyoid bone. A finger in the incision recognized the hyoid and forceps were thrust through the mylo-hyoid into the floor of the mouth under the tongue. (Figs. 11 and 12.) A rubber drainage tube was inserted. A secondary incision below the left angle of the jaw and countercommunicating drainage between the two incisions was added. The patient did not do well. She was delirious and cyanotic. It was evident that a tracheotomy must be done and that the tongue was not sufficiently drained. January 14, 1923, this was accomplished none too soon. She ceased breathing on the operating table and a hasty, high tracheotomy was done.

Exploration of the previous incision showed that it extended well into the floor of the mouth, but not into the body of the tongue. The finger reach had been too short. A No. 32 F. male sound was thrust into the tongue along the drainage tract with the evacuation of pus and blood and a tube drain replaced. Her condition was critical for a few days, nasal feeding was necessary for several days, after which her convalescence was rapid. The tracheotomy tube was removed ten days after its insertion. She began talking in about a week. The tongue remained much swollen for six weeks.

Ludwig's angina is recognized as a condition with a rather high mortality. It is a gangrenous myositis of the intrinsic muscles of the tongue and of the floor of the mouth associated with profound toxæmia and with great danger of an oedema of the glottis. It is usually treated by lateral, submaxillary incision and its accredited mortality is 40 per cent. The reporter had treated since 1913 ten cases with one death, a fortunate result, for which the procedure to be described is in part responsible.

A median incision is made under chloroform anaesthesia, from the upper edge of the thyroid cartilage upward one inch. This is carried down to the hyoid bone. The point of the scalpel is thrust through the fascia and the mylo-hyoid muscle above the hyoid and a pointed clamp or scissors entered in its place. This is opened and a finger thrust deeply into the body of the



## GALL-BLADDER RÖNTGENOGRAM SHADOWS

tongue which will be found to be gangrenous. The finger is then turned and hooked into the tongue so that its tip can be moved by the finger. If the neck is too thick and the finger too short a 32 F. male sound with a Van Buren curve is used instead. A large tube drain is inserted deeply. It may be necessary to drain one or both submaxillary regions as well, but the deep lingual drainage is essential. In cases of doubt a low tracheotomy should be done.

DR. JOHN C. A. GERSTER said that, not knowing about Doctor Jennings' method, he had used the same procedure about six days ago. The patient had had a lingual abscess which had been incised about ten days previously by his family physician and quite a large amount of pus evacuated. He did not return for treatment, and gradually developed a tender swelling of the entire sublingual region, including that part of the tongue just in front of the glottis. When Doctor Gerster saw him he had no fever and only slight difficulty in swallowing. He was kept under observation for a few days because of the possibility that the symptoms would subside. At the end of the fourth day there was a rise in temperature to  $100.8^{\circ}$ , and the swelling had increased in size. Doctor Gerster made a transverse incision, just above the hyoid bone, went into the depths of the tongue in the midline, and struck a foul abscess, pus from which showed bacteria on spread but gave negative aerobic culture. The laboratory was unable to make an anaerobic culture. The man stayed in the hospital for three days and then left in good condition, having no fever and no pain on swallowing. The submaxillary induration was painless, but still persistent. There was a moderate amount of drainage.

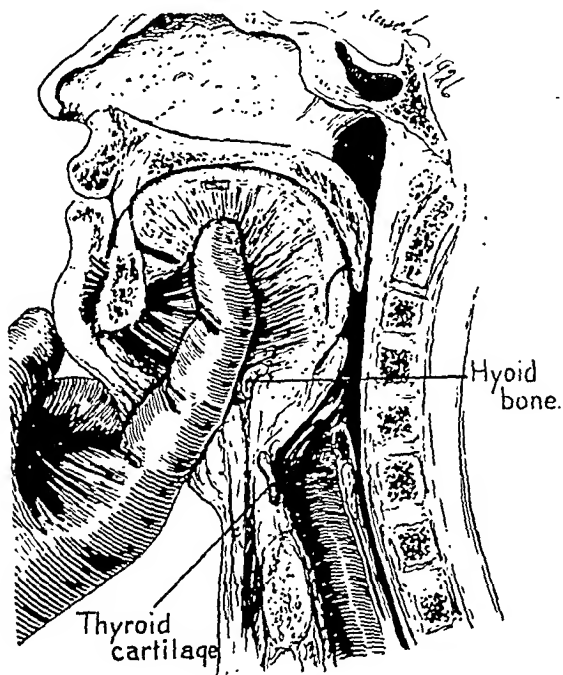


FIG. 12.—Finger thrust up into centre of infected area.

## GALL-BLADDER RÖNTGENOGRAM SHADOWS

DR. FRANK S. MATHEWS showed cholecystograms with unusual features. A patient for a long time had had attacks of pain after bed time suggesting gall-bladder but not quite so severe as those of ordinary cholelithiasis. The dye was given by mouth and was wholly absorbed. The first exposure showed an unusually large, clearly defined gall-bladder larger than any he had seen. He estimated its capacity at four ounces. The first film after taking food showed a gall-bladder practically the same size as before. Exposures were made over a period of two and a half days, in all of which the gall-

bladder shadow was visible, becoming progressively smaller, with possibly deepening shadow. At operation, the gall-bladder was found everywhere adherent, the fine adhesions probably resulting from a previous operation. The gall-bladder was both large and thin and had the usual normal blue color. The mucosa appeared normal. The pathologist reported atrophic gall-bladder. The epithelium was everywhere well preserved. The interest in the case lies in the prompt filling, the unusual size of gall-bladder, the inability to empty in two and a half days, the association of this condition with fairly definite clinical attacks. It is also of interest that a gall-bladder demonstrated to be one with an unusual degree of stasis apparently over several years, yet showed no tendency to formation of stones nor inflammatory signs in its musculature or mucosa.

#### SIDE-TRACKING OPERATIONS FOR COMMON AND HEPATIC DUCT OBSTRUCTION

DR. ALLEN O. WHIPPLE read a paper with the above title, for which see page 540.

DR. WILLIAM CRAWFORD WHITE said that he happened to be in Boston March 3, 1927, when Dr. Hugh Williams showed the case Doctor Whipple had referred to as a nine-year post-operative cure. The patient was a small boy four years of age in 1913, at the time he had had the fistula; so it was fourteen years since operation, last March. He had gone to the Massachusetts General Hospital this time with acute appendicitis, and they had felt sure his symptoms must relate to his former condition. It proved to be entirely separate and distinct.

DR. HUGH AUCHINCLOSS added one case to those Doctor Whipple had presented. The patient was a woman, who had had the ordinary gall-stone symptoms and had a large gall-bladder containing a number of stones. The gall-bladder was removed. Two days later the laboratory reported a small area of carcinoma in the wall of the thickened chronically inflamed gall-bladder. One gland in the region of the free margin of the lesser omentum had been noted. The patient went for about a year before returning with increasing jaundice. She was again operated on and the free margin of the lesser omentum found to be here much thickened and hard, so that structures in it were unrecognizable, and though it was impossible to determine whether this was inflammatory or carcinomatous, the presumption was strong that it was carcinoma. No specimen could be removed with safety from this mass. Doctor Auchincloss was inclined to abandon the idea of doing anything, but by dissecting toward the portal fissure a small triangular portion of the hepatic duct was found distended and available for anastomosis. The stomach lay near, so that it was possible to unite the stomach to this triangular area. This was done by uniting the stomach to the hepatic duct posteriorly by a continuous suture. Then three or four Halsted mattress interrupted sutures were placed but not drawn taut, to unite the two structures anteriorly. By holding these up as in a Finney pyloroplasty, it was possible to make a

## SIDE-TRACKING COMMON DUCT OBSTRUCTION

hole in the stomach and then in the small triangular area in the hepatic duct and complete the anastomosis by simply tightening and tying the mattress sutures. Another patient had a simple cholecystectomy done that same day. It was thought the simple case would do well and the other patient probably would die. The contrary proved to be the case, for the simple case had a stormy few days while the patient with anastomosis had an easy convalescence and had soon lost all evidences of jaundice. After several months' remission, however, her jaundice returned and she died at home. This case shows that in spite of progressive jaundice and malignant metastasis with only a small amount of dilated hepatic available duct it is sometimes possible to give temporary relief.

DR. JAMES N. WORCESTER said that the question of the etiology of pancreatitis is obscure and the only thing one could ascribe it to is infection of the biliary tract. He had seen considerable benefit follow gall-bladder drainage with subsidence of the chronic pancreatitis and spontaneous closure of gall-bladder fistula. It seemed to him this simple procedure was a possibility which should be considered.

DR. FORDYCE B. ST. JOHN said that inasmuch as prophylaxis should be considered in handling these cases, it seemed to him that in spite of the fact that there were good results in the case he was interested in, it might have been prevented by being satisfied with simple drainage, rather than cholecystectomy during which the hemorrhage took place.

DR. EDWIN BEER stated it was difficult to decide whether the increasing number of cases of complicated post-operative pathology of the biliary tracts was due to the fact that more surgeons were doing gall-bladder work, or whether perhaps some of these unfavorable results had developed as a result of the recommendation to remove the gall-bladder by starting at the cystic duct end. This latter technic surely is somewhat risky not only in acute infections but even in interval cases. Using this technic, throwing the ligature around what seemed to be the cystic duct and then dissecting from the fundus down to the ligature which had been left untied, on several occasions he had found that the ligature surrounded the right hepatic or common hepatic ducts rather than the cystic duct, demonstrating very clearly the danger in some of these cases of this procedure. He also felt that the use of the bridge and introduction of drains towards the gastro-hepatic ligament while the patient was still on the bridge, might contribute by fixation and scar tissue development to some of the angulations in the deep ducts which make for permanent obstruction—partial or complete. A drain placed in this way could readily, as soon as the bridge was dropped, press against the deep ducts and pull them forward as soon as the bridge was lowered. If the drain were gauze, the danger of such traction would be much greater than when using a rubber tube or rubber-dam.

## BRIEF COMMUNICATIONS

### A MODIFIED SUPRA-PUBIC PROSTATECTOMY\*

EUGENE FULLER's supra-pubic prostatectomy has received very little modification since its origin, with the exception of the control of post-operative bleeding by suture and by the Pilcher bag. From the standpoint of technical refinement, the usual supra-pubic operation cannot be compared

with the anatomic perineal prostatectomy of Young. The removal of the prostate, supra-pubically, is generally so simple, by the average technic, that it can hardly be called a major surgical procedure; the danger from the operation depending mostly upon the general condition of the patient. Perhaps the most undesirable result is the loss of the membranous urethra, leaving the bladder mucosa and the upper end of the remaining urethra separated for several inches. After natural processes have made a channel connecting the urethra and bladder, the passageway is frequently tortuous and obstructed, producing no little difficulty for the patient in emptying his bladder.

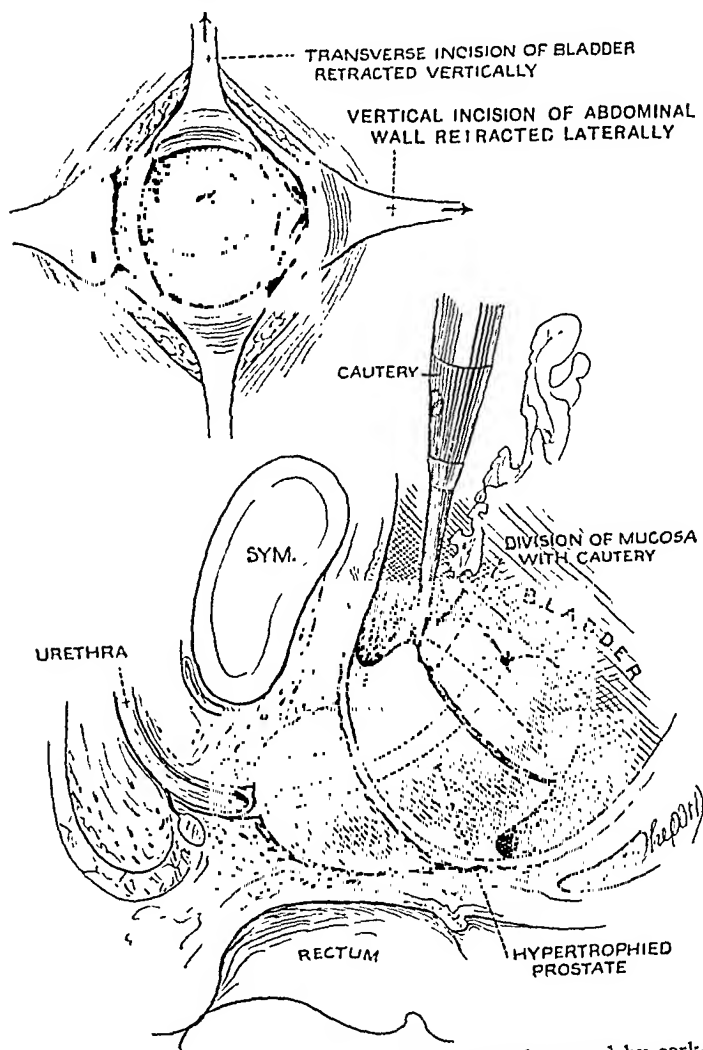


FIG. 1.—The prostate should be shown pulled upward by corkscrews. Note the transverse incision in the bladder which allows ample exposure.

The operation I am presenting may have some advantages over the older and well-tried Fuller procedure. It cannot be performed on patients whose general condition will permit only a hasty enucleation and in those patients whose prostates are fixed *in situ* by adhesions. When this operation can be per-

\* From the Department of Surgery, University of Nebraska.

# A MODIFIED SUPRA-PUBIC PROSTATECTOMY

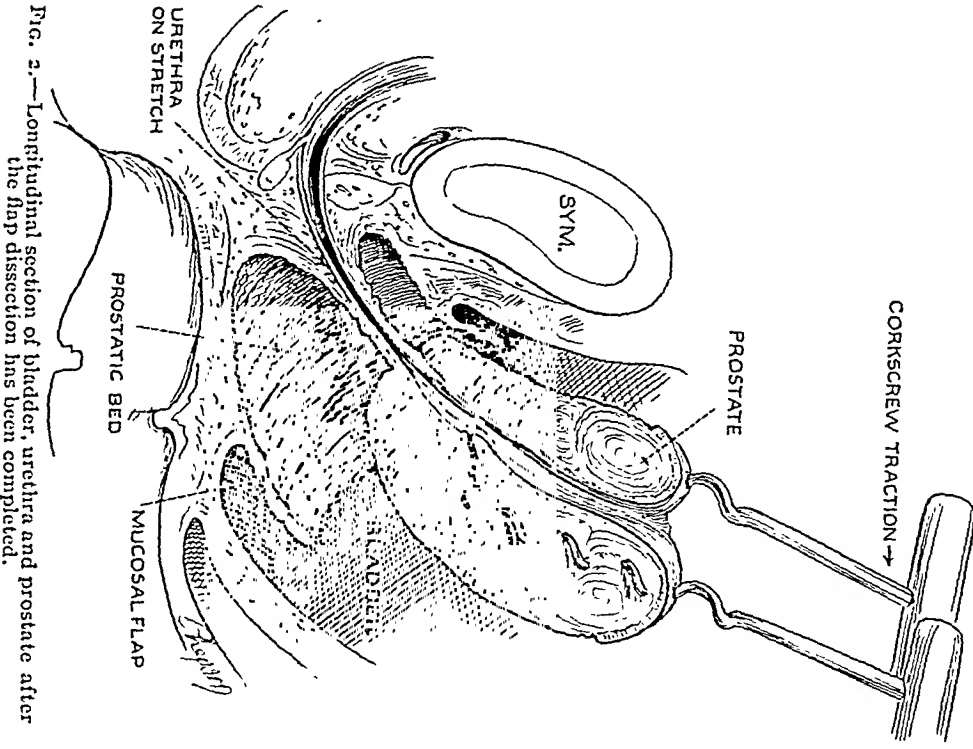


FIG. 2.—Longitudinal section of bladder, urethra and prostate after the flap dissection has been completed.

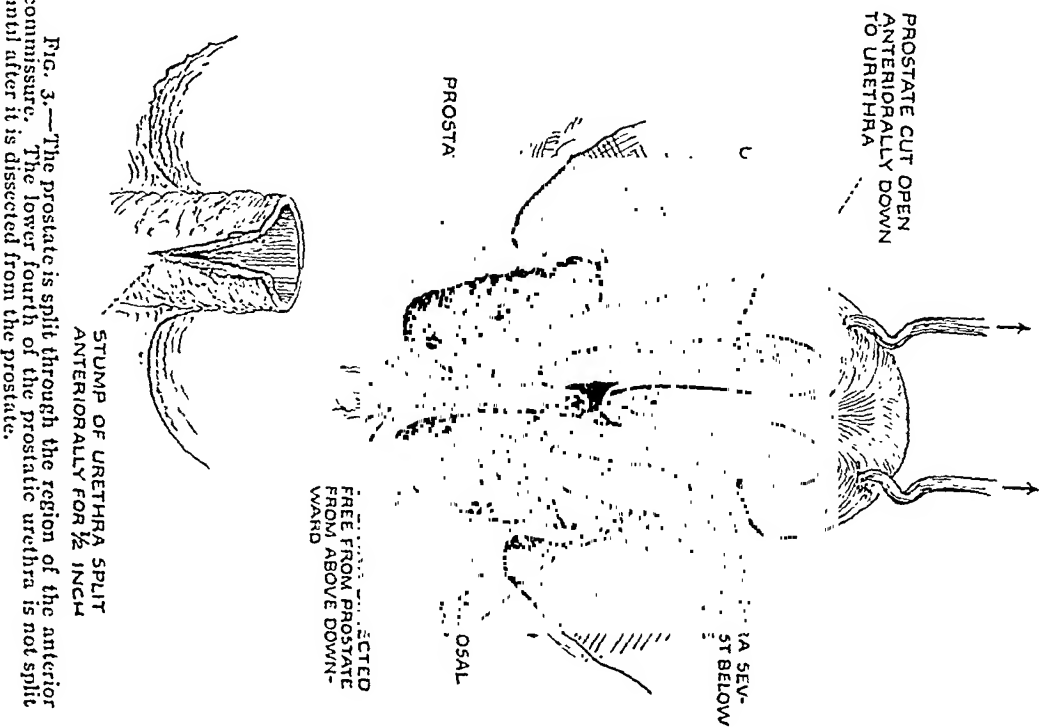
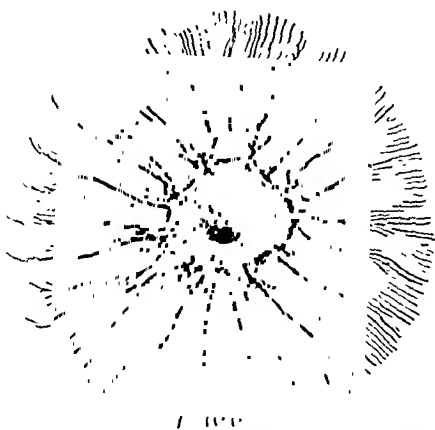


FIG. 3.—The prostate is split through the region of the anterior commissure. The lower fourth of the prostatic urethra is not split until after it is dissected from the prostate.

formed, it results in: (1) Control of bleeding; (2) a direct union of the lower prostatic urethra with the bladder mucosa, resulting in a more patent urethra; and (3) a smoother post-operative recovery. The disadvantages of this operation are its difficulty of performance and the length of time required. When the technic of this operation can be carried out, the post-operative loss of blood is so slight that it can well be compared with Edwin Davis' technic which he has so successfully devised to prevent bleeding during his performance of Young's Anatomic Perineal Prostatectomy.

*Technic.*—As stated previously, the medium size hypertrophied prostate, not firmly fixed by adhesions to surrounding structures and with a membranous urethra which allows for considerable stretching, are the anatomical conditions desirable for the performance of this operation. When the patient's general condition is not satisfactory and a speedy operation of a few minutes' duration is essential, this operation, at present, is not recommended.



SPLIT URETHRA SUTURED TO  
MUCOSAL FLAPS OF BLADDER

FIG. 4.—The bladder mucosa sutured to the urethra. There is a greater amount of bladder mucosa compared with the urethral than is shown in the diagram. Four interrupted sutures are about all that can be inserted.

A vertical incision through the abdominal wall and a transverse incision through the bladder gives the best exposure. Ordinary cork-screws are forced into the prostate for traction and an electric cautery blade, or preferably a very sharp knife, is used to cut the bladder mucosa around the midlateral portion of the prostate. The bladder mucosa is then cut away from the lower portion of the prostate with scissors, or brushed away with gauze. Steady traction on the screw handles with upward pressure in the rectum, soon elevates the prostate and puts the urethra on a stretch. An intravesical lamp is desirable, particularly when suturing the bleeding points in the prostatic bed. After the prostate has been liberated, it should be split open through the anterior commissure. This is easiest done with a scissors, placing one blade within the urethra. The lower third or fourth of the membranous urethra is then dissected from the prostatic bed. After this portion of the prostatic urethra has been dissected from the prostate, it is split for about one-half inch downward in its anterior portion and attached to catgut sutures which keep it in view. The prostate, which is now unattached, is then removed from the bladder and the bleeding in the prostatic bed attended to with sutures. The mucosal flaps in the bladder are attached to the urethra by interrupted fine chromic gut sutures which is the most tedious part of the operation. Only about three or four such sutures can be used. A small rubber catheter, no larger than No. 17 F., should be inserted through the

## SUBACUTE GASTRIC PHLEGMON

urethra and left protruding into the bladder. A supra-pubic drain should be left in four or five days.

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*Omaha, Nebr.*

## SUBACUTE GASTRIC PHLEGMON\*

A man, aged forty-six years, entered the Wesley Memorial Hospital, November 12, 1926, with signs and symptoms of an acute appendicitis, that started thirty-six hours previously. For the past month, patient had not been feeling well, was weak and felt vague abdominal distress. Temperature 98.6, pulse 80, leucocyte count 12,000. A grid-iron incision was made under combined novocain, nitrous oxide and ether anæsthesia. The appendix was found to be embedded in the lateral wall of the cæcum with its tip perforated into the mesocolon of the ascending colon. It was freed and amputated at the base. A large mass of thickened, friable omentum covered the cæcum. Both in the omentum and in the mesentery, several chains of lymph-glands were palpable. No mesenteric thrombosis was noted. The abdomen was not explored and the wound was closed except for a small strip of gauze inserted in the subcutaneous tissue. There was a foul discharge for a few days. The wound was completely healed on the twelfth day and patient discharged on the sixteenth day after operation. There were no chills during convalescence.

The appendix was 12 centimetres long. There was a kink close to its tip. It is here that perforation took place. Histology showed an acute suppurative appendicitis.

The man returned to work and felt completely well. Two months after the operation, he suddenly developed a pain in the epigastrium and under the right costal margin. This pain was dull, constant, had no relation to food and did not radiate. He did not vomit. His temperature had risen to 101° Fahrenheit.

He was seen on February 11, 1927, three weeks after the onset of the new symptoms. Examination revealed a vague, slippery, tender mass in the epigastrium, which extended to the right lobe of the liver and followed respiratory movements. His temperature was normal, pulse between 90-100; blood-pressure 125-80. Laboratory findings were: Red blood-cells, 4,000,000; white blood-cells, 16,000; hæmoglobin, 85 per cent. Wassermann reaction was twice negative. Gastric analysis showed F. H. A. 59, T. A. 76, no blood and lactic acid were present. The X-ray findings revealed an irregularity of both lesser and greater curvatures, a prepyloric defect and a deformed duodenal bulb. There was a large residue at the end of five and a slight residue at the end of twenty-four hours.

The pre-operative diagnosis was a pyloric stenosis, probably due to inflammatory extragastric compression. Patient was given a gastric lavage three times before the operation. His last leucocyte count dropped to 7000, thus indicating a subsiding inflammation.

Laparotomy was performed on February 14, 1927. Midline incision from xyphoid process to the right of the umbilicus was made under combined novocain-nitrous oxide anæsthesia. The peritoneum was adherent to the anterior wall of the stomach and could only be opened to the left of the midline. A soft boggy mass was exposed of the size of a child's fist involving the lesser curvature of the stomach, the suspensory ligament, the right lobe of the liver and the anterior peritoneum. The stomach was freed from

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\* From the surgical department of Northwestern University Medical School.

these structures. The entire anterior wall was hyperæmic, œdematous. The pylorus was open; the first portion of the duodenum was pulled upward toward the inflammatory mass, thus explaining the duodenal deformity. Both lesser and greater omentum were thickened and several lymph-nodes were palpable both here and at the pylorus. The stomach was well mobilized from pylorus to the ascending portion of the lesser curvature and about three-fifths of the stomach was resected. The pylorus was closed in three layers and covered with omentum. The upper half of the gastric stump was closed and inverted; the lower half was anastomosed with a short retrocolic jejunal loop. The cut wall of the stomach did not bleed, was glassy in appearance. The abdominal wall was completely closed.

*Gross Pathology.*—The resected part of the stomach showed two small erosions on the lesser curvature about 4 centimetres from the pylorus. A large area of the mucosa was dark red, almost hemorrhagic. The wall of the stomach was markedly thickened, œdematous with a translucent appearance. The serosa was covered with a large mass of fibrinous exudate. It gave the macroscopic appearance of a diffuse phlegmon. For histological study two sections were taken, one from the site of the erosion at the angle of the stomach, the other from the cardiac end of the resected portion.

*Post-operative course* was uneventful except for a diffuse bronchitis during the first three days. Bowels moved on the third day. Stitches were removed on the eighth day and primary union was obtained. He was put on a modified ulcer diet for two weeks, after which a general diet was permitted with five meals a day.

Three weeks after the operation a fractional test made showed no free acidity in any portion, total acidity varying from 18 to 29 points, no lactic acid and a faint trace of blood. X-ray on March 8, 1927: The stomach holds 10 ounces readily. There is a definite retaining power of the stomach. Peristalsis vigorous and progressive. There is no dilation of the proximal or the distal loop. After three and a half hours there is a slight residue of barium in the stomach. After four and a half hours the suture line of the closed pouch is faintly imbibed with barium. Red blood-cells, 4,280,000; white blood-cells, 4800; hæmoglobin, 75 per cent.

Six weeks after the operation, patient had gained twenty-five pounds and was ready to go back to work. He complained of some constipation. June 3, four months after the operation, patient was perfectly well, gained twenty-five pounds. August 1: No complaints, no anæmia.

*Histological Report.*—(Dr. R. H. Jaffé.) Section 1. The wall of the stomach is very much thickened. It measures from 14 to 16 mm. The thickening is due to the development in the subserous part of a cellular tissue which is composed mainly of large, round or oval cells with an ample foamy cytoplasm. The nuclei are round, rich in chromatin and often show an indentation of the membrane. Some of the cells contain small chromatin granules in the cytoplasm. Between these cells there are found a varying number of cells, lymphoid cells, eosinophile and neutrophile leucocytes. The latter cells arrange themselves in some places to dense clumps. Here their nuclei are often broken up and their outlines become indistinct. A few large giant cells with from 8 to 15 nuclei are found scattered between the other cells.

Thin-walled, capillary blood-vessels run through the cellular masses. Attached to their wall are seen round or oval cells with deeply stained nuclei and an homogenous slightly basophilic cytoplasm. In some of these cells single vacuoles are present and it is from these cells that the large foamy cells develop. This is demonstrated by numerous transitional stages.

In the middle of the cellular zone an oval area is observed. It is made up of degenerated leucocytes, structureless cell débris and shreds of fibrin. The foamy cells with the other elements arrange themselves concentrically about this area.

Toward the external surface of the stomach the tissue becomes denser and the



## SUBACUTE GASTRIC PHLEGMON

foamy cells are less numerous. Lymphoid cells and polymorphonuclear leucocytes are predominating. This zone is very rich in new-formed capillaries which are dilated and filled with blood. In one place a group of foreign body giant cells is found. The cells are located about structureless hyaline masses with chromatin granules. A large artery found near this place has an obliterated lumen which is filled by a loose connective tissue with wide capillaries.

The cellular infiltrations extend into the muscularis. The foamy cells become gradually replaced by lymphocytes, neutrophile and especially eosinophile leucocytes. By these cellular infiltrations the muscle fibres often are widely separated.

The submucosa is thickened. A poorly stained fluid separates the fibrilles of the connective tissue. There are small perivascular accumulations of lymphocytes and eosinophile leucocytes. The lymph-vessels are much dilated and filled with a homogeneous mass. Many of them also contain polymorphonuclear leucocytes. The mucosa is œdematous with numerous large lymph follicles. The epithelium of the glands is rich in beaker cells.

*Section 2.*—The submucosa is the thickest portion of the wall. It is formed by loose connective tissue with much pale-stained material between the fibrilles. The lymph-vessels are dilated. The muscularis, too, shows a loosening of its structure by much fibrillar tissue separating the bundles of muscle fibres. A tag of granulation tissue is attached to the outside of the stomach. It contains an enormous number of giant cells which engulf structureless material stained purple or blue in the hæmatoxyline-eosine sections.

*Diagnosis. Healing Phlegmonous Gastritis.*—The foamy cells are histiocytes which have phagocyted lipid material set free from breaking down pus cells. Remnants of the suppurative process still are visible in the foci of degenerated leucocytes. The process seems to have started in the subserosa.

*Comment.*—According to the histological report, the wall of the stomach showed a subacute inflammatory process, which started in the subserosa. The origin of the infection may have been in the appendix, which has been personally observed to cause very marked involvement of both veins and lymph-vessels in the omentum. The sections gave no evidence as to whether the infection was carried through the lymphatics or whether a retrograde venous thrombosis in the gastric vessels might have been responsible. That a lymphatic connection of appendix and duodenum and appendix and stomach is of clinical importance has been strongly emphasized by the studies of Flint (Moynihan). The possibility of retrograde venous thrombosis from mesenteric into gastric vessels has led Payr into excessive experimental studies. Omental ligations have been reported by Eiselsberg to cause gastric hemorrhage. The possible rôle of intra-abdominal infections, particularly of the appendix in gastric pathology, is suggestive in this case. This is all the more important as the gastric phlegmons hitherto reported originated in foul carcinomatous ulcers of the stomach, in gastric ulcers, or in diffuse polyposis of the stomach, the gastric wall being invaded from the mucous membrane; or as a localization of generalized infection as in a case of Meyer, Brams and Guy (see lit.). Most of these are post-mortem records, but a few cases recovered after gastrectomy.<sup>1, 2, 4</sup> In our case, the process seems to have started in the subserosa, later invading the submucosa and causing mucous erosions.

The history of the patient indicates that at the time of operation the acute symptoms were subsiding. Three weeks before admission, the patient's temperature was  $101^{\circ}$  Fahrenheit. On the day of admission, the white cell count was 16,000. On the day before operation, the white count dropped to 7000. Corresponding to this clinical picture, the microscopic sections show no acute suppuration, no abscesses as seen in the acute gastric phlegmon, but only small foci of degenerated leucocytes and an intensive phagocytosis. A granulation tissue dominates the field, the phlegmon is in a healing stage.

The motor insufficiency of the stomach was well marked by the twenty-four-hour residue of the barium meal. That the oedematous submucosa with its macrophages would have given place to a diffuse fibrosis is highly probable. We would then have a picture of a diffuse fibrosis of the stomach, a leather-bottle stomach, the inflammatory variety of which has only recently been emphasized by Wyard. Some of the so-called syphilitic and carcinomatous infiltrations may only be chronic inflammatory processes. Of the 38 cases of *limitis plastica* published from the Mayo Clinic only 80 per cent. were carcinomatous. (Lyons.) This condition then might be interpreted as intermediary stage, a missing link between an acute gastric phlegmon, which has been described by several authors and an inflammatory leather-bottle stomach, the etiology of which is yet undetermined. In the past history of such patients an acute stage seems possible but is not mentioned.

The gastric retention together with the diffuse involvement of the stomach indicated partial gastrectomy. A gastrojejunostomy might have flared up the phlegmonous process and would have left the infiltrated gastric wall to continue its process of involution and perhaps involve the new opening.

In Eiselsberg's case a gastric phlegmon developed after gastrojejunostomy made in the presence of a broken-down gastric carcinoma.

The partial gastrectomy, as very often seen, resulted in an anacidity, which, however, as shown by the undisturbed digestion of an unrestricted diet has no functional significance. After four months, no intestinal disturbance and no anæmia is present. The partial closure of the gastric stump, whereby only the lower half has been anastomosed with the jejunum, may have had an influence on the retaining power of the gastric stump which is present in the X-ray films as early as three weeks after the operation. Also the increase of the gastric capacity in such operations is well emphasized by this case.

*Summary.*—(1) A case of subacute diffuse gastric phlegmon is described, for which partial gastrectomy was done with complete recovery.

(2) This condition is interpreted on the basis of clinical and histological findings as an intermediary stage, a missing link, between a gastric phlegmon and a diffuse fibrosis of the stomach sometimes called leather-bottle stomach of the inflammatory type.

(3) Partial gastrectomy in this case was followed by good functional results.

# VOLVULUS NEONATORUM

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## VOLVULUS NEONATORUM DUE TO ANOMALOUS INTESTINAL ROTATION

A male infant, born January 29, 1924, appeared normal and healthy at birth, weighing 9 pounds, 8 ounces. On the second day he began to vomit dark green fluid and to pass blood from the bowels. He nursed well only part of the time and ejected most of the food in from twenty to thirty minutes. Vomiting, and blood in the stools increased progressively and he lost weight.

At regular intervals the stomach was lavaged and the infant transfused with small amounts of whole blood. By the twenty-fifth day there was marked distention of the abdomen, with visible peristalsis in the region of the stomach, leucocytosis of 22,000, and loss of weight of two pounds. Fluoroscopic examination at this time revealed an obstruction in the lower duodenum where the barium stopped. Congenital duodenal obstruction was diagnosed by Dr. J. G. Kramer who referred infant for immediate operation.

February 23, operation was performed by Dr. Carl R. Steinke through a rectus incision under light ether anæsthesia. When the peritoneum was opened the stomach popped out, because it was greatly distended with gas. The gastrocolic omentum was torn about half its width, as the colon was fixed and not allowed to come out with the stomach. The transverse colon near the hepatic flexure was posterior to the first part of the jejunum, and

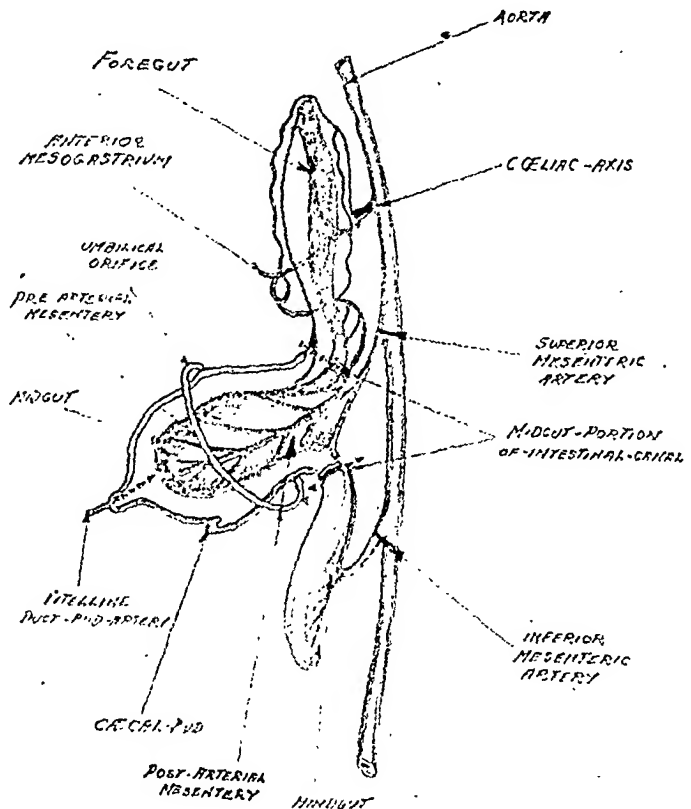


FIG. 1.—Schematic representation of primitive alimentary tract at about fifth week. (After Dott.)

The gastrocolic omentum was torn about half its width, as the colon was fixed and not allowed to come out with the stomach. The transverse colon near the hepatic flexure was posterior to the first part of the jejunum, and

there was complete twisting of the small intestine over the colon. The jejunum was kinked, causing almost complete obstruction. The pyloric opening was dilated widely and the duodenum distended to 2 cm. in diameter down to the third portion where it was fixed. The whole intestinal mass was removed from the abdominal cavity and turned in a counter-clockwise direction, the colon being allowed to come in front of the first part of the jejunum. With relief of obstruction gas passed readily through the jejunum. The stomach was emptied of gas by pressure, through the œsophagus. The intestines and stomach were then replaced in the abdomen. The infant went into shock, so the tear in

the gastroduodenal omentum was not sutured and the abdomen was closed rapidly.

Four days after the operation the weight dropped to 7 pounds 7 ounces, then began to increase steadily. The baby left the hospital, March 5, the eleventh day after operation. At this time the weight had increased to 8 pounds 3.5 ounces, the vomiting and hemorrhage had ceased entirely, and child had essentially recovered.

The volvulus in this case implicated the whole original midgut from the first part of the jejunum to the splenic flexure of the colon. The mass of intestine with its lack of fixation had rotated in the wrong (clockwise) direction, approximately one complete turn, or 360 degrees.

## COMMENT

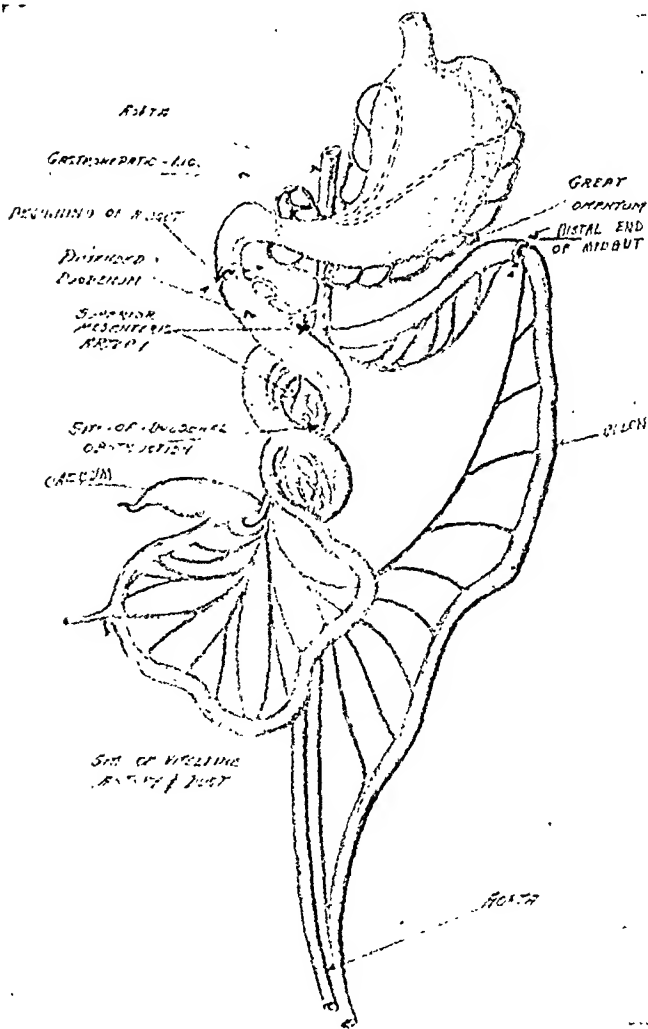
Anomalies of intestinal rotation are undoubtedly more common than a review of the literature would indicate. The cases without symptoms, and

FIG. 2.—Volvulus of midgut. Twist of approximately 450 degrees in the wrong (clockwise) direction. (After Dott.)

those with mild symptoms that do not come to operation or necropsy, would not be recognized.

Dott,<sup>1</sup> in 1923, published a comprehensive description of the embryology, mechanism and pathology involved, including all clinical phases of the subject. He noted forty-five cases of gross congenital malposition of the midgut in a review of the literature and added five cases of his own.

This condition takes its greatest toll in early infancy, usually a result of high intestinal obstruction. It generally occurs at the duodenocolic isthmus which is situated at the base of the great loop forming the midgut, and



## VOLVULUS NEONATORUM

includes its blood supply, the superior mesenteric artery. This artery is considered the axis around which the midgut rotates during fetal development. The volvulus seems to cause no interference with circulation.

The symptoms point to obstruction in the region of the upper portion of the small intestine, often simulating congenital stenosis of the duodenum, pyloric stenosis, volvulus of a small loop of gut, intussusception, or pressure due to a mesenteric cyst. The presence of bile in the vomitus and the fact that the food is not ejected immediately after being ingested usually points toward obstruction below the pylorus. A successful röntgenogram is of great value.

At operation in infants, for volvulus due to anomalous intestinal rotation, there will be great distention of the stomach, pylorus and upper duodenum. The colon is not apparent and may be found with difficulty. The duodenum may present itself uncovered by the large bowel and having a free mesentery. In non-rotation the duodenum will pass down the right side of the root of the mesentery (as there is no duodenojejunal flexure) and the ascending colon will pass up the left side. In reversed rotation the transverse colon will lie behind the origin of the superior mesenteric artery, and the duodenum in front. The ascending colon will be in its normal situation but there is no duodenojejunal flexure.

In exomphalos the physiological and embryological hernia of the midgut into the root of the umbilical cord has persisted until birth (Dott), and it is not a true umbilical hernia.

At operation in an infant for exomphalos, the extruded bowel illustrates quite vividly the failure to rotate of the midgut. The cæcum here is usually situated in the left side of the abdominal cavity, in almost the reverse of its usual situation at this age, where it is normally found in the right upper aspect. The ileum may occupy the right side of the cavity. Rotation is accomplished manually with ease. In these infants the distribution of the midgut may not change materially after the twelfth week of embryological life.

In volvulus neonatorum early operative interference holds out the only hope of saving life. Dott suggests reduction of the volvulus by delivering the intestinal mass and untwisting, with an approximation of normal conditions. He also suggests artificial fixation by suture of the cæcum and ascending colon to the right loin. If reduction is impossible because of adhesions, gastrojejunostomy may be successful.

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## NOTE ON LUDWIG'S ANGINA

Few articles on Ludwig's Angina are to be found in the literature of the past ten years, and scarcely any two of these are in entire agreement as to the surgical procedure to be applied. The condition is, therefore, of sufficient rarity and interest to warrant a discussion of the following case, which occurred recently in the writer's private practice.

Mrs. A. Q., aged twenty-two years, was admitted to the Rochester General Hospital, complaining of swelling in the submental region, three days' duration. According to the history elicited, three weeks prior to admission to the hospital she had developed an impetigo sore on her chin, which persisted in spite of sundry forms of treatment. Three days before admission there appeared a progressively increasing submental swelling, which was considered a lymphadenitis. Shortly after admission the swelling had increased so that movements of the tongue were a little embarrassed. Some twelve hours later she had an acute attack of dyspnoea. The floor of the mouth was now markedly swollen and both submaxillary regions were full, especially the left. Temperature, 101.2; pulse, 110; respirations, 20; white blood-cells, 10,200.

Under local anæsthesia, a vertical incision was made from the chin to the hyoid bone, separating the muscles down to the floor of the mouth; a few drops of pus were obtained on the right side. Through this incision, the shelf formed by the mylohyoid muscles could easily be felt on both sides. A small rubber tube was inserted into each supra-mylohyoid area for purposes of drainage.

During the next twenty-four hours all of the patient's symptoms became much worse—viz., difficulty in breathing and swallowing, swelling in the submaxillary region, and swelling of the tongue and of the floor of the mouth. Under local anæsthesia, incisions were then carried laterally from the vertical incision to divide both geniohyoids, both anterior digastrics, and both mylohyoid muscles. Only a few drops of pus were obtained. Following this procedure, the patient made a very satisfactory convalescence. The œdema in the mouth and neck began to subside in about twenty-four hours. She was discharged on the fourteenth day.

The foregoing case presented several unusual features: (1) In its pathogenesis—practically every case recorded has arisen from an internal source, such as a carious tooth following tooth extraction; an ulcerated oral mucous membrane; a fractured mandible; and occasionally an angina, or a quinsy. The source of this case, however, was an infected lesion of impetigo contagiosa on the chin. In the usual case—with an internal focus—the submaxillary lymph-glands, since they drain the oral cavity, are the first group involved. But in this case—with its external focus—the initial development was an acute lymphadenitis in the submental region—with the process finally extending through the mylohyoid diaphragm to involve the loose connective tissue in the floor of the mouth; *i.e.*, to the development of a *true* Ludwig's Angina.

(2) The insufficiency of the first operation demonstrated that it is a misconception to believe that one has simply to open or perforate the diaphragm formed by the two mylohyoid muscles, and that then the supra-mylohyoid space can be drained. In the case here reported, it was found that the two tubes so inserted did *not* drain, and that their presence actually increased the tension on the floor of the mouth, so that clinically the patient was not improved.

(3) The sufficiency of the second operation was due to a proper conception of Ludwig's Angina, based upon a study of the anatomy of the region and of the pathological conditions present.

*Anatomical Considerations.*—In reviewing the anatomy of the region, stress should be given to the character and relationships of the mylohyoid muscle. This muscle forms a floor for the cavity of the mouth, a diaphragm covered by dense fascia superficially, which acts as a distinct barrier to the extension forward and externally of any infection in the floor of the mouth. It arises from the mylohyoid ridge of the mandible and extends from the symphysis in front to the last molar tooth behind. The posterior fibres pass inward and slightly downward, and are inserted into the body of the hyoid bone. The middle and anterior fibres are inserted into a midline raphé. The relations of the mylohyoid muscle are given as follows: by its superficial surface—with the platysma, the anterior belly of the digastric, the suprahyoid aponeurosis, the submaxillary gland, submental vessels, and mylohyoid vessels and nerve; by its deep surface—with the geniohyoid, part of the hyoglossus and styloglossus muscles, the hypoglossal and lingual nerves, the submaxillary ganglion, the sublingual gland, the deep portion of the submaxillary gland and duct, the sublingual and ranine vessels, and the buccal mucous membrane.

*Pathological Considerations.*—At the time of operation there is usually no abscess. Only a few drops of pus, if any at all, are seen—occasionally in the submental region, but more commonly in the submaxillary region. What is present is a tense œdema. The patient's symptoms undoubtedly cannot be accounted for by the œdema superficial to the diaphragm of the mylohyoids. What does push up the patient's tongue, thus causing the mechanical symptoms, is the marked œdema of the loose cellular tissue in the floor of the mouth—*i.e.*, on the oral side of the mylohyoid diaphragm. It is this pressure that must be released.\* Here, then, is the crux of the surgical treatment of Ludwig's Angina: it is not incision and drainage that is most important, but rather release of pressure. For this reason, I now favor a long transverse incision of the mylohyoid diaphragm, extending laterally on each side almost throughout its entire breadth. For the same reason, I also favor the simple horizontal incision of the skin parallel with and one finger's breadth below the jaw.

Several authorities recommend incision of the submaxillary salivary gland or opening of its external capsule in all cases. Dr. E. Rehn, of Freiburg, recently recommended total extirpation of the submaxillary salivary gland, on the side primarily involved, as a means of preventing extension of the process posteriorly to the carotid sheath and thence down the fascial planes to the mediastinum. In the case reported above, no such radical surgery was necessary.

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\* The author is indebted to Dr. H. L. Prince for a personal communication substantiating this conclusion.

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## BOOK REVIEW

TROPICAL SURGERY AND SURGICAL PATHOLOGY, by Karuna K. Chatterji. New York, William Wood and Company, 1927. Octavo, cloth, pages 244. Freely illustrated.

Sir Havelock Charles, in an appreciative foreword, says that this book is the first of note that has been brought out on Tropical Surgery. If this is true, and the reviewer knows nothing to the contrary, the book occupies a position of unusual importance, especially at this time when by the improved means of communication that the world enjoys, all parts of the world are made akin. The author himself points out the diffusion of tropical diseases which has resulted from the Great War, thus increasing the importance of the familiarity upon the part of western surgeons with diseases which formerly had been felt to be peculiarly the province of surgeons practicing in the east and in the tropics. The book itself is primarily a British publication republished in America with a New York imprint.

According to the author, India is an epitome of the world. Here one finds the coldest and hottest climates and all degrees of humidity and moisture. The student who looks for materials for the study of tropical surgery and pathology finds India the ideal country. The author states that the European can easily maintain good health in the tropics by prudence and attention to clothing, suitable food and beverages, avoidance of chills, over-exercise, late rich dinners, and dinner parties. There are, however, many surgical conditions common in the tropics and peculiar to it which are of infective origin. It is the diffusion of these infections which are related to the diseases of tropical origin diffused by the Great War.

The author is of the opinion that operative hazards are generally greater in the tropics than in temperate climates. Chloroform is the standard anæsthetic according to the author. With proper precautions regarding purity, preparation of the patient and after-treatment, he thinks it safe and useful, particularly in the absence of skilled anæsthetists.

Naturally, the first place and the greatest space in the book is given to the consideration of amœbiasis in its various manifestations and particularly those due to *entamoeba coli* and *entamoeba histolytica*. This section includes the first ten chapters and is of great interest and positive value. Next in order comes the subject of filariasis to which eight chapters and sixty pages are devoted. The various forms of lymphatic obstruction and their results in all parts of the body are treated seriatim. The well-known forms of elephantiasis render this section of the book particularly striking. Then follows a section on tropical granulomata including the Maduro foot, Yaws,

## BRIEF COMMUNICATIONS

the Delhi boil, tropical ulcer and others. The author's remarks upon all these conditions are very informing and will command the interest and increase the knowledge of the reader.

The style of the author, as a whole, is simple and straightforwardly descriptive and commends itself to the reader. The writer is telling what he has seen, what is his individual experience, so that a personal interest is sustained from the beginning to the end of the book. We commend it unreservedly.

LEWIS S. PILCHER.

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## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA<sup>1</sup>

BASED ON A FURTHER STUDY OF END RESULTS IN SIXTY-NINE CASES

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IN NOVEMBER, 1923, before the New York Surgical Society, I read a paper on *Prognosis in Giant-cell Sarcoma of the Long Bones Based Upon the End Results in a Series of Fifty Cases*;<sup>2</sup> and the present paper includes a careful follow-up of these cases as well as a report of nineteen additional cases since observed. The entire series should furnish sufficient data from which to form some definite conclusions on two important, and at present unsettled, points; namely: (1) whether giant-cell sarcoma is always a benign lesion, and (2) what is the best method of treating these cases.

In my earlier paper on the subject I took issue with Bloodgood and, perhaps, with the majority of pathologists, on the assumption that giant-cell sarcoma of the long bones is always benign and never gives rise to metastases. A further clinical and pathological

study of additional cases personally observed, as well as those reported in literature, serves to strengthen the opinion which I have already expressed,



FIG. 1.—Giant-cell sarcoma of fibula treated with X-rays alone by Doctor Herendeen. Patient well four years later.

<sup>1</sup> Read before the New York Surgical Society, March 9, 1927.

<sup>2</sup> ANNALS OF SURGERY, March and April, 1924.

that, while the majority of giant-cell sarcomas are benign or at least only locally malignant, there is a certain number of cases which, while possessing the clinical, röntgenological and pathological features of benign giant-cell sarcoma—and are so classed by competent pathologists—do, nevertheless, give rise to metastases and generalization of the disease, thus proving that the diagnosis of benign tumor was incorrect. Moreover, I believe that in the early stages of the disease, it is impossible always to differentiate the malignant from the benign type. In my earlier paper, already referred to, in

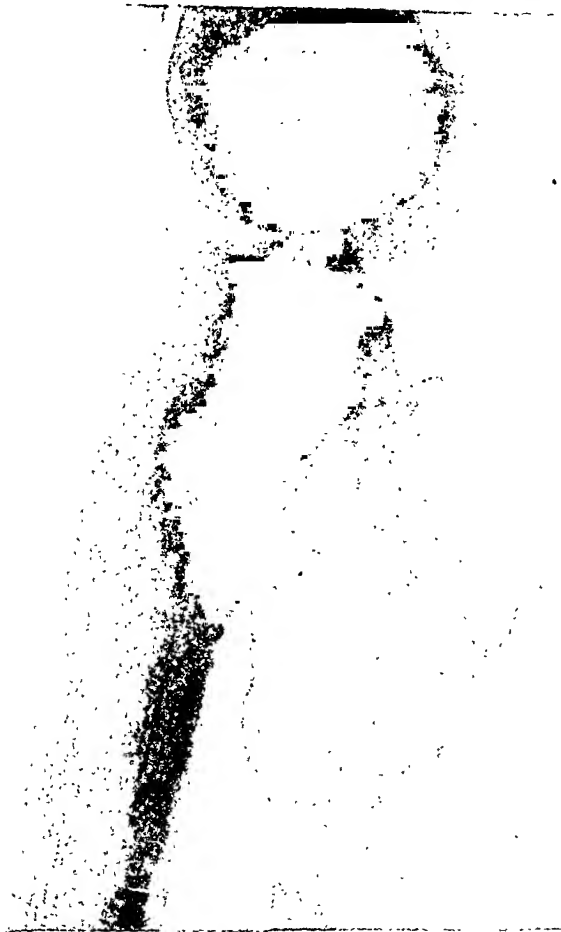


FIG. 2.—Preceding case, one year after treatment was begun.

fifty cases of giant-cell sarcoma of the long bones in which the diagnosis was made by competent pathologists, in no less than ten cases the patient died of metastases. It is only fair to state that a number of these cases were observed many years ago when the pathology of these tumors was less clearly understood.

Since the publication of my paper, the malignant nature of some of these cases of giant-cell sarcoma has been pointed out by other surgeons. McWhorter and MacGuire,<sup>3</sup> in a series of twenty cases (collected from the records of New York, Presbyterian and

Bellevue Hospitals), diagnosed as giant-cell sarcoma, found four to be malignant, the proportion being identical to that found in my own series. Finch and Gleave<sup>4</sup> report a case of typical, benign, giant-cell sarcoma of the femur—the diagnosis being based on the clinical, Röntgen-ray and pathological evidence—which later developed pulmonary metastases. Fortunately, in this case an autopsy was secured, thus permitting a study of the microscopic section of tumor of the lung. A full report of this case follows:

*A Case of Osteoclastoma (Myeloid Sarcoma, Benign Giant-cell Tumor) with Pulmonary Metastasis.*—E. F. FINCH and H. H. GLEAVE report the following case from the Department of Pathology of the University of Sheffield:

<sup>3</sup> Archives of Surgery, vol. ix, p. 545, November, 1924.

<sup>4</sup> The Journal of Pathology and Bacteriology, vol. xxix, 1926.

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

W. B., aged forty-nine, was admitted to the Royal Infirmary, Sheffield, on March 17, 1917, with a fracture of the lower third of the right femur, the result of slipping on ice. Good apposition of the fragments could not be obtained by manipulation, and a week later the site of the fracture was explored. It was found then that the bone was so softened that a nail could be pushed into it by simply pressure of the fingers. A diagnosis of osteitis deformans was made, and after manipulation of the fragments into a better position the wound was closed, no foreign body having been left in the bone. The fracture healed, no further skiagrams being taken owing to the stress of work.

His leg gave him no further trouble for eighteen months. He then had pain at the site of the old fracture and noticed swelling in the region of the right knee-joint. He was then sent by his doctor for a course of massage to the Edgar Allen Institute; this is an institute for remedial exercises and massage in Sheffield.

In February, 1921, he returned to the Royal Infirmary with a swelling of the lower end of the right femur. The report of the skiagram by Dr. Rupert Hallam was "myeloid sarcoma". The skiagrams taken at the time of the accident in 1917 were then reexamined and found to show definite evidence of a medullary tumor at the site of fracture. On further interrogation the patient gave the history that he had had "rheumatism" in the right knee-joint in 1915 and had damaged the "ligaments" in 1916. The condition of things was explained to him; no treatment could be suggested except amputation. It was pointed out to him that local removal of the tumor would leave the bone so thin that fracture would be inevitable. He was advised to carry on with the aid of a caliper splint until the inevitable spontaneous fracture occurred; amputation would then be done. In the meantime he could continue with his work. It was explained to him that the tumor was not malignant. He fully appreciated the fact that he could earn more with two legs than after amputation. His case was followed up and he reported from time to time that everything was satisfactory.

He commenced with pain in the leg again in December, 1924, and on January 18, 1925, he was again admitted to the Royal Infirmary with a spontaneous fracture of the right femur. The leg was amputated through the middle of the thigh on January 21, 1925, well above the tumor. The wound healed normally and an artificial limb was provided. The pathologist's report of the tumor was "myeloid sarcoma".



FIG. 3.—Preceding case, four years after treatment was begun.

On October 2, 1925, the patient was readmitted. For some days he had had great pain in the stump, which was swollen, red, oedematous and extremely tender. The diagnosis was made of abscess formation, due to hitherto latent sepsis in the bone. He was operated upon the same afternoon with a big incision. When, however, sinus forceps were pushed into the mass, there was no pus; only blood clot and growth were evacuated. The next day the patient was spitting blood-stained sputum. He stated that he had been

doing this since July, 1925. His lungs were examined by X-rays and Doctor Hallam reported "typical secondary deposits of new growth present in both lungs". In view of this no operative interference with the stump was advised. He became wasted and cachectic and on January 28 he had a severe hemorrhage from the stump and the femoral artery was tied. He died on January 30, 1926.

*Clinical Comment.*—The case has points of great clinical interest. When first admitted in 1917 the history did not suggest a spontaneous fracture. The presence of myeloid sarcoma was not diagnosed either by the skiagram or even at operation. A portion of the soft bone should have then been removed for examination and the diagnosis would then have been probably made earlier. The treatment then advised would have been amputation as union of the femur in the presence of myeloid sarcoma would be so uncertain and unsatisfactory. Stress of



FIG. 4.—Giant-cell sarcoma of lower end of femur, treated primarily by operation. The tumor promptly recurred and was treated with X-ray. Patient well at present, two years later; walks with limp.

work owing to the war must be made the excuse for the mistake in diagnosis by omission of further skiagrams, etc.

No foreign body was inserted at the operation because of the diagnosis of osteitis deformans. No one was more surprised than the surgeon in charge of the case (E. F.) when union occurred.

It was only in February, 1921, when the clinical appearance was obviously that of a medullary tumor of the lower end of the femur, that the skiagrams of March, 1917, were reexamined. It could be then clearly seen that the growth was already present four years previously. He was not urged to submit to amputation on account of the subsequent disability. He had had the growth at least four years; it was doing no harm except increasing in size. The size was such in 1921 that amputation was the only course available. The tumor was obviously benign in the clinical sense. Why not

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wait for the inevitable fracture and then amputate? This occurred in January, 1925. Amputation was performed and the case apparently in the clinical sense was finished. Not at all; the tumor metastasized and produced death on January 30, 1926. From which history we may learn that (1) a fracture at the site of a myeloid sarcoma may heal soundly; (2) it is not safe to trust to the benignancy of this tumor.

One of the writers (E. F.) has watched another case of myeloid sarcoma develop for four years until the inevitable spontaneous fracture occurred, necessitating amputation, but he is quite sure he will never watch another.

*Histology.—Deposits in Lungs.*—The histological appearance varies considerably in different areas. The tumor tissue is chiefly composed of interlacing bundles of spindle-shaped fibrous tissue cells forming intercellular collagen. Areas of well-formed fibrous tissue are numerous throughout the tumor. As compared with the spindle-celled areas of the primary growth, the cells here are more closely packed and have larger, more active looking nuclei. In the more cellular areas giant cells of malignant type are common and occasionally multipolar mitoses are seen. The general appearance here is that of a fibrosarcoma.

While in some fields this spindle-celled tissue alone is seen, in the majority of the sections a striking feature is the presence of giant cells of osteoclast type. These cannot be distinguished in their general aspect or nuclear characteristics from the giant cells of the primary growth. In many areas they are collected together in large numbers and form the predominant feature of the section.

This case may be summarized as follows:

1. A case of osteoclastoma (myeloid sarcoma) of the lower end of the femur is reported, of at least nine years' duration, in which metastasis to the lungs has taken place.
2. The metastases have the histological characters of the primary tumor, with numerous typical giant cells and in addition an admixture of fibrosarcomatous tissue.
3. This case, and other cases from the literature to which we refer, confirm the neoplastic character of these tumors, and leave no doubt that, though usually slow-growing and only of local malignancy, they are essentially sarcomatous.



FIG. 5.—Preceding case, two years after treatment with X-ray by Doctor Herendeen.

GOFORTH, of Philadelphia (*Archives of Surgery*, December, 1926), has published another case of malignant giant-cell tumor with lung metastasis, a brief report of which is as follows: A male patient, aged thirty-four years, struck his left knee against a chair in 1916; pain and slight swelling followed. A few months later he entered the Polyclinic Hospital (service of Doctor Cooperman and Doctor Case), where a diagnosis of giant-cell tumor was made. In 1917, or one year after the injury, a thorough curettage was done. The tumor recurred and was again curetted in 1919. A second recurrence developed, and the patient was again admitted to the hospital, at this time complain-

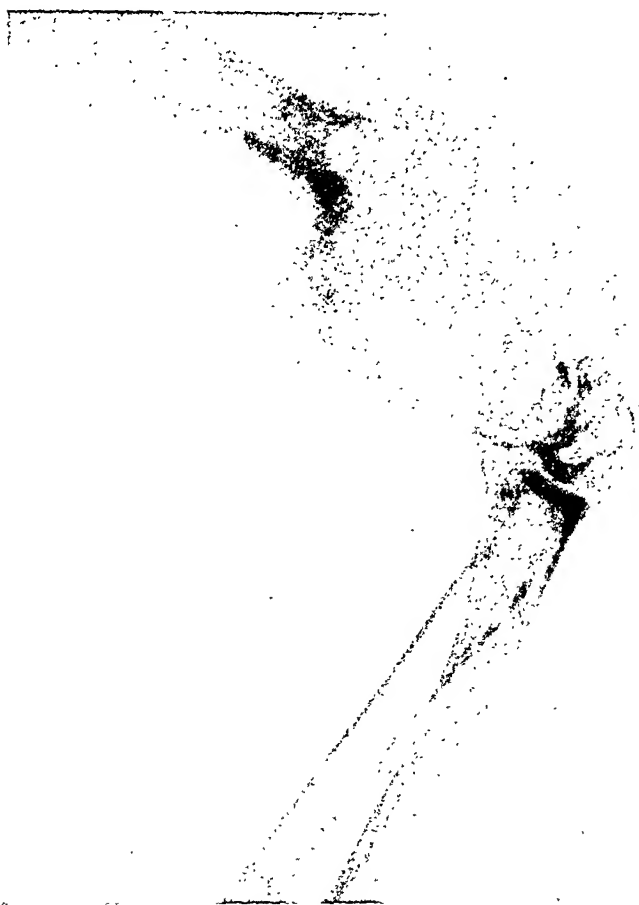


FIG. 6.—(Case No.) Giant-cell sarcoma (clinical and röntgenological diagnosis) treated with X-rays in 1925. Patient developed metastasis to the jaw two years later. (Memorial Hosp. Case.)<sup>6</sup>

ing of inability to use the left leg and frequent attacks of sharp, needle-like pains throughout the knee. He had had to use braces and crutches for the preceding ten months. Physical examination revealed an irregularly enlarged knee, twice the size of the normal knee, which was tense and tender, and quite hard in some areas. There was complete loss of function. The routine laboratory tests were negative. A röntgenogram showed a bone destroying neoplasm involving the upper part and head of the left tibia, the head of the fibula, and the posterior portion of the internal condyle of the femur. In October, 1921, the leg was amputated well above the knee. In August, 1922, the patient again returned to the hospital complaining of cough and substernal pain on coughing. He had been spitting up blood for the last five months, had lost much weight, and had

grown progressively weaker. A röntgenogram of the chest revealed definite evidence of lung metastasis. The patient failed rapidly and died in November, 1922. In regard to the pathological examination, Goforth says: "Tissues from the first and second curettements unfortunately were not available for this study, but were reported as showing the structure of typical giant-cell tumor. Dissection of the tumor in the amputated leg revealed a destructive, soft cellular, invasive sarcomatous growth involving all the bones and soft tissue about the knee-joint.

"Sections taken from different portions of the neoplasm showed many areas composed of closely packed, thick, spindle-shaped cells, scattered through which were numerous large, multinucleated giant cells of the epulis type. Very little fibrous supporting

<sup>6</sup> This case is selected from the Memorial Hospital cases by Kolodny, in his study of the Bone Registry cases as a "Typical Benign Giant-cell Tumor." It well illustrates the impossibility of making a correct diagnosis of giant-cell sarcoma, from clinical and X-ray data alone.



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tissue was present. Other areas consisted almost exclusively of spindle cells, relatively constant in size and staining reaction but showing numerous karyokinetic figures, suggestive of rapid growth. Still other areas consisted of closely packed, varying sized, deeply staining, rounded or polyhedral cells, scattered through which were many irregular giant-cells, not of the epulis type, containing varying amounts of cytoplasm, and from one to four or five large, deeply staining oval nuclei, many of which were dividing. No areas of calcification or ossification were demonstrable. Dr. E. A. Case of the Polyclinic Hospital described the condition as 'giant-cell sarcoma with a number of areas of actively growing cells' and our study of the various sections suggested that basically the tumor was a true giant-cell tumor, which now showed malignant transformation, an opinion in which Dr. James Ewing concurred."

This case Goforth regards as both atypical and unusual. Briefly, "the tumor followed injury; was treated by curettement after a year; recurred and was treated again by curettement two years later; recurred a second time with the aspects of malignancy and was treated by amputation five years after and caused death by metastasis, proved röntgenologically, six and one-half years after the appearance of the original growth; so it would seem that we are dealing with a true giant-cell tumor that had undergone malignant transformation."

Among the conclusions reached by Goforth are the following:

1. The known behavior of the giant-cell tumor warrants its being classified as a true neoplasm.
2. The giant-cell tumors constitute a series. Those at the lower end of the scale possess relatively adult fibrous stromas and are essentially benign. They exhibit more cellular, and active stromas, composed chiefly of relatively immature fibroblastic cells and become increasingly more locally aggressive as the scale is ascended.
3. Under the stimulus of inadequate or improper treatment, they may recur locally, those at the upper end of the scale being especially liable to this tendency. Such recurrences, as a rule, are more aggressive or virulent than the primary growth, both clinically and microscopically.
4. They are potentially malignant and may as a result of repeated or improper treatment excitation on rare occasions undergo malignant transformation and metastasize.

The last two reports are most convincing as they include not only complete clinical and Röntgen-ray evidence but a microscopical study of the primary and metastatic tumors as well.

The differential diagnosis of giant-cell sarcoma of the long bones has



FIG. 7.—Preceding case, in October, 1925, seven months after treatment was begun by Doctor Herendeen.

already been discussed in my previous paper so that it will be unnecessary to review it here. The principal object of the present paper is to discuss more fully the best methods of treating giant-cell sarcoma of the long bones. I feel that there is great need of such discussion for the reason that there seems to be much doubt in the minds of most surgeons as to what is the proper method of procedure to employ in these cases.

*Biopsy.*—The first question that arises is, shall a biopsy be performed before any method of treatment is adopted? Upon this point there is the

widest variance of opinion. I believe there is a growing tendency to forego biopsy and to trust to a clinical and Röntgen-ray diagnosis in tumors of the long bones, particularly of the supposedly benign giant-cell type. The reason for this, I believe, is due to the fact that there is a very definite but, in my opinion, exaggerated fear that exploratory operation is attended with considerable risk, such as, an ensuing and slowly healing sinus which is liable to become infected, and furthermore, that there is danger of producing gen-




FIG. 8.—Preceding case, September, 1926, marked local improvement but shortly after developed metastases of the jaw.

eralization of the disease if the tumor proves to be malignant. As stated before, I believe that these dangers have been greatly over-estimated. At the same time, biopsy or exploratory operation in giant-cell sarcoma should never be performed merely for the sake of securing a piece of tissue for microscopic study; but should consist of as complete curettage as possible, down to healthy bone followed by an application of zinc chloride or carbolic acid to the cavity. In other words, the exploratory operation should be a very important part of the treatment itself. To simply cut into a giant-cell sarcoma without thoroughly curetting down to the bone, is to court disaster. In the first place, hemorrhage is produced which it is difficult to control; and in the second place, infection is far more likely to occur than if complete curettage had been performed.

*Curettage.*—Curettage for central tumors of the long bones has been widely

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employed by continental surgeons, but more generally so by American surgeons since Bloodgood has shown that curettage followed by the use of carbolic acid or zinc chloride has resulted in a very large proportion of cures (80 per cent.). Curettage is not the simple

operation it is generally believed to be, especially if the tumor is of considerable size. It should not be undertaken lightly by the surgeon who has had little experience with these conditions nor by any other than the one who is to have final charge of the patient. One of the dangers to be guarded

against is that of hemorrhage. These tumors are extremely vascular, and fatal hemorrhages have resulted from a simple curettage. Hence, the operation should always be performed under a rubber tube tourniquet, and



FIG. 9.—May, 1923. Giant-cell sarcoma of upper end of humerus following recent fracture. Treated with toxins for five months, then one radium treatment. Tumor steadily increased in size until November, 1923, when it began to gradually decrease. Patient in good health four years later. Arm useless from musculo-spiral paralysis.



FIG. 10.—Preceding case, September, 1923.

quent infection, which, many writers state, is sure to occur; and (2) the danger of sinus formation, which sinus may persist for a very long

should always be as complete as possible, that is, it should extend down to hard, healthy bone, thus lessening the chances of a recurrence as well.

### *Treatment of Cavity.*

—Surgeons at present are divided in opinion as to the treatment of the bony cavity left after curettage. The older method advocated by Bloodgood and still very generally employed, that is, packing the wound with gauze, has very definite disadvantages. The principal ones are:

- (1) the danger of subse-
- (2) the danger of sinus formation, which sinus may persist for a very long

time. For these reasons, many surgeons have abandoned gauze packing and have attempted to close the wound entirely, hoping to get primary wound healing. A number have attempted to fill the cavity at the time of operation with various substances, *e.g.*, fragments of bone, fat or muscle grafts. Owing to the free bleeding that almost always occurs, such grafts seldom survive; and they may favor the production of the infection or sinus-formation which they are supposed to prevent. Some surgeons have used bismuth or iodoform paste; but these have proved even more objectionable



FIG. 11.—Preceding case, November, 1923.

and have now been abandoned. One patient who had been treated in this way, later came under my care. The sinus had become infected and I had to perform another curettage to get rid of the paste. This was never entirely accomplished. The sinus persisted for more than a year when it became re-infected and a secondary amputation had to be performed. No evidence of the tumor was found. The patient died some months later of nephritis.

I have never used any of these methods nor do I believe them necessary.

My own results show that since the introduction of Dakin's solution, it is possible in practically all cases to prevent infection, even if the cavity is packed with gauze. Gauze packing is the only method that permits the complete control of hemorrhage in the advanced and very vascular cases. I had one case, an extensive sarcoma involving the knee-joint as well as the upper end of the tibia, in which a very large cavity was left after curettage, and the hemorrhage could not have been controlled in any other way than by gauze packing. Of course the limb was supported by a plaster cast which was applied from the foot to the pelvis. The packing was removed as soon as possible, two or three days later, and the wound was kept clean with Dakin's solution. The cavity filled rapidly by healthy granulations and the sinus had completely healed in three and one-half months (prophylactic toxin treatment was begun a few days after the operation and one radium treatment was given at the end of three months). Here we have a striking example of Nature's success in dealing with extensive bone destruction. Röntgenograms taken five years later

showed complete restoration of the condyles as well as the destroyed area of the tibia, and there was perfect functional result. This patient remained well for eight years and then died of hemorrhages from child birth. If we can deal successfully with such extensive cases as this without resorting to resection and bone grafts, then we ought to be able to manage the simple and less advanced cases.

When dealing with smaller cavities, the gauze packing may be removed in twenty-four or forty-eight hours, thereby lessening the danger of infection. It should be remembered that most of the cases of severe infection that have been emphasized by Ewing and others, occurred before the days of Dakin's solution. I had two cases in my own series, in which I was obliged to amputate on account of very severe infection; but these were the only ones in a large number of cases. I have had only one since I began using Dakin's solution, and this followed the introduction of bismuth paste by another surgeon, and was further aggravated by the injudicious use of radium in the presence of an already existing infection.



FIG. 12.—Preceding case, December, 1924.

In certain cases, especially in those of the pelvic bones, I strongly advise against curettage or operation of any kind inasmuch as experience has shown that in these cases the cavity often fails to heal and becomes more easily infected than in the long bone cases, often resulting in a foul, fungating tumor which adds greatly to the patient's discomfort and hastens his death. I have seen three such cases, yet it is only fair to state that these were all malignant osteogenic sarcomas. I do not believe that the diagnosis of giant-cell sarcoma of the pelvic bones can be made with any degree of certainty; and therefore, in all cases of tumor of this region I advise radiation combined with systemic injections of the mixed toxins of erysipelas and *Bacillus prodigiosus*. Prac-

tically all these cases have reached the inoperable stage when first observed. Benign giant-cell tumors of these bones are extremely rare.

*Toxins.*—In addition to curettage, and carbolic acid or zinc chloride applied to the cavity, I believe that the administration of injections of the mixed toxins of erysipelas and *Bacillus prodigiosus* for a period of three or four months after operation greatly lessens the chances of a recurrence of the disease, by destroying whatever cells have been left behind. When used as a prophylactic measure, only small doses of the toxins are given, just enough

to produce mild reactions, and thus the treatment interferes but little with the patient's ordinary routine of life. If it is possible to eradicate extensive tumors and to effect a permanent cure by the use of the toxins alone, without curettage, as our series of cases proves, then there is certainly strong theoretical grounds for using the method as a routine measure after operation. The end-results in the cases thus treated support this view.

*Radiation.*—There is,

I believe, an increasing

tendency on the part of surgeons to turn over all cases of bone sarcoma, especially giant-cell sarcoma, to the radiologist. The surgeon is led to believe that most cases of giant-cell sarcoma can be cured by radiation without surgery of any kind; and furthermore, that a correct diagnosis can be made from the röntgenograms alone, without biopsy, in practically every case.

In a recent and valuable contribution to the subject of *Malignant Disease of the Bones*, Nové, Jossierand and Tavernier of Lyon, France, state that the present data available in France are insufficient to permit any definite conclusions as to the value of radiation in giant-cell sarcoma. They state that, strangely enough, Regaud, Director of the Radium Institute of Paris, has had no experience with radiation in giant-cell tumors of the long bones, although, he has successfully treated three cases of epulis of the jaw. The authors mentioned have observed one case of giant-cell tumor of the ulna treated by radiation after curettage and ulceration, without effect, amputation later being



FIG. 13.—Preceding case, August, 1926.

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necessary. Their conclusions on the subject are as follows: "It seems, on the whole that 'tumeur myeloplaxes' (giant-cell tumors) are but slightly radio sensitive . . . We have no radiographs followed for a long time, to show what happens to the bony cavity after a cure."

Up to the present time twenty-nine cases of giant-cell sarcoma of the long bones have been treated by radiation at the Memorial Hospital and the results obtained in this series, I believe, enable us to answer in the affirmative the mooted question as to

whether or not it is possible to cure giant-cell sarcoma by this method of treatment. This series includes five cases (one treated by radium and four by Röntgen-ray) in which the tumor was apparently completely controlled, and the normal function of the limb was restored. While these results prove that it is possible to cure giant-cell sarcoma by radiation alone or following curettage, the number of cases so treated is too small and the period

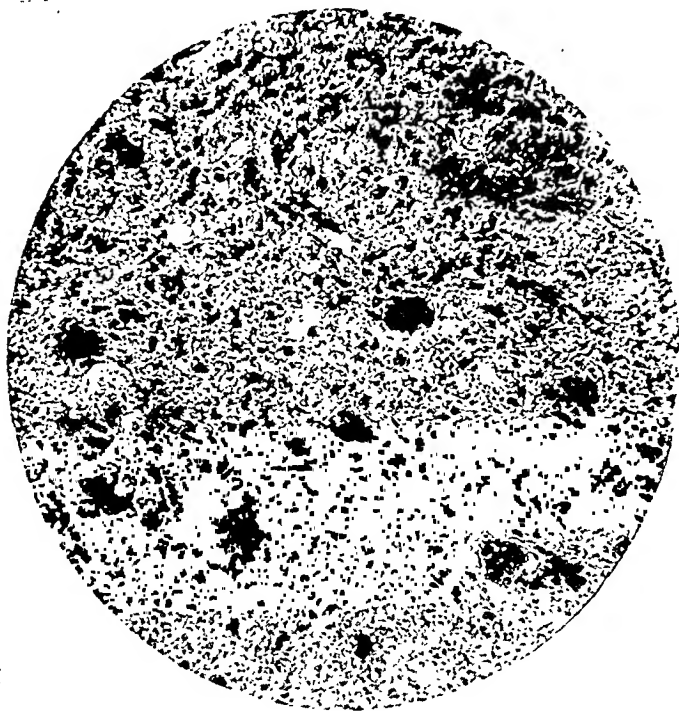


FIG. 14.—Microphotograph of preceding case.

of observation is too short—compared with the series treated by surgery alone or by surgery and toxins—to permit the conclusion that radiation should be the method of choice.

There are certain disadvantages associated with radiation as the *primary* method of treatment. The first in matter of importance is the difficulty, and in some cases, the impossibility, of making a positive diagnosis of benign giant-cell tumor from the clinical and Röntgen-ray evidence. Our series shows that this error in diagnosis, that is, the inability to tell whether the tumor is benign or malignant, occurs so frequently (in one out of five cases) that it cannot be ignored. Our series contains four cases that were treated as benign giant-cell tumors, the diagnosis being based on the clinical and Röntgen-ray evidence, which later proved to be malignant tumors. Hence, the importance of a histological examination in these cases.

Another distinct disadvantage is the long duration of treatment, often extending over a period of one or two years, and thus entailing prolonged disability. This, in the case of a working man or woman, is a consideration of great importance. The period of disability in cases treated by surgery, or surgery and toxins or by toxins alone, has been found to be much shorter.

The results obtained by a combination of curettage and radiation have not been entirely satisfactory. As Nové, Josserand and Tavernier have stated, the use of radium after curettage increases the chances of infection. The case of Bancroft,<sup>6</sup> referred to in my previous paper on the subject,<sup>7</sup> illustrates the unsatisfactory results that sometimes follow this combination. In two of my own cases of giant-cell sarcoma involving one condyle of the femur, I used radium and Röntgen-ray following thorough curettage. In one case



FIG. 15.—Giant-cell sarcoma of lower end of femur, treated with X-rays alone. Patient in good health with excellent functional result, three and one-half years later.

a fracture occurred two years later in a bone rendered brittle by prolonged radiation (150,000 mc. hours given over a period of one year); and in the other case, a secondary amputation had to be performed two years later for an intractable and most painful ulcer caused by over-radiation. In both or in all of these cases, it must be conceded that the unfortunate results were due to over-radiation or an injudicious application of a method, rather than to the method itself; and we have hoped that the poor or indifferent results obtained in the earlier treatment of sarcoma of the bone, with increased knowledge of technic,

might give place to far better results. However, up to the present time, our results, while highly interesting and most encouraging, especially the results obtained by Doctor Herendeen with the Röntgen-ray, are not in my opinion equal to the results obtained by surgery alone; and they are distinctly inferior to those obtained by a combination of surgery and toxins.

We believe that it is impossible at present to state definitely which form of radiation, that is, radium, high-voltage or low-voltage Röntgen-ray, gives the best results. A study of the individual cases treated at the Memorial Hospital shows apparent cures resulting from the use of any one of these methods.

<sup>6</sup> Clinics of North America, December, 1921, p. 1747.

<sup>7</sup> ANNALS OF SURGERY, March and April, 1924.



## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

At present the majority of cases of giant-cell sarcoma at the Memorial Hospital are being treated by Doctor Herendeen with high-voltage Röntgen-ray.

One of the most interesting cases of our entire series, in the opinion of Bloodgood, is worthy of note.

This patient, a female, aged fifty-five years, fell and injured her shoulder in February, 1923, producing a spiral fracture. A few weeks later a tumor developed. The patient came under my obser-

vation in May, 1923. At this time examination showed a large tumor pressing on the musculo-spiral nerve causing complete wrist-drop. A biopsy was performed revealing a giant-cell sarcoma. This was pronounced a benign tumor by both Bloodgood and Ewing. The patient was given injections of the mixed toxins for six weeks, at the end of which time, one radium-pack treatment (12,000 mc. hours) was applied over three areas at a distance of 6 cm. She then returned home where the toxin treatment was continued for several months by her family physician, Dr. J. H. Reid, of Troy, N. Y. I examined her in September, and found a huge tumor extending out over the pectoral region nearly to the sternum, and backwards over the scapula. I regarded it in spite of the microscopic diagnosis as, probably, an infiltrating, malignant tumor. The toxin treatment was continued for a few months longer; no further radium was used. Instead of going on to a fatal issue, as I believed certain, the tumor began to decrease slowly in size during the month of November, and continued to do so for a year or more. The patient's general health remained good throughout the entire period. At the present time, four years later, there is a comparatively small, hard mass at the site of the huge tumor, made up, undoubtedly, of regenerated bone which has taken the place of the tumor and the destroyed portion of the humerus. In this case I think we must give the credit of the satisfactory result to both the toxins and radium. If a single dose of radium was responsible for the disappearance of this very large tumor, then we are greatly over-treating our cases in giving repeated doses over a prolonged period of time, that is, many months or years. In the case just cited, in spite of the apparent cure of the disease, the arm is and always will be quite useless on account of the complete musculo-spiral paralysis and ankylosis at the shoulder joint; and undoubtedly the patient would have been better off had an early amputation been performed. Note: When my former paper went to press, I regarded the patient's condition as hopeless.



FIG. 16.—Preceding case, three and one-fourth years later.

*Method of Choice.*—My personal opinion based upon the data thus far available is, that the method of choice in the treatment of giant-cell sarcoma or giant-cell tumor presumably of the benign type, is surgery (thorough curettage followed by carbolization) combined with prophylactic toxin treatment. In some cases, especially in the very extensive ones, it may be advisable to give in addition, a single radium-pack treatment but in a very moderate dose as prolonged radiation after curettage interferes with the normal and rapid

healing of the wound and filling up of the cavity with healthy granulation tissue, and furthermore, it predisposes to infection.

A brief synopsis of our entire series of sixty-nine cases treated by various methods, follows:<sup>8</sup>

#### GROUP I

*Cases Treated Primarily with X-rays or Radium without Previous Biopsy*

1. E. Giant-cell sarcoma or cyst of upper end of humerus (clinical and röntgenological diagnosis) treated by X-rays. Patient well at present, five years.

2. M. Giant-cell sarcoma of lower end of femur

(clinical and röntgenological diagnosis) treated with radium alone, 90,000 mc. hours, over a period of one year. Patient well with normal function five years later.

3. G. Giant-cell sarcoma of lower end of radius treated with X-rays alone over a period of two and one-half years. Patient well four years later.

4. G. Giant-cell sarcoma of upper end of tibia (clinical and röntgenological diagnosis) treated with X-rays alone over a period of two years. A pathologic fracture occurred. Amputation was performed. Microscopical diagnosis by Doctor Ewing: probably telangiectatic central sarcoma of mild malignancy (?) Toxin treatment given after amputation. Patient alive two years later but in very poor health.

5. F. Giant-cell sarcoma of upper third of fibula (clinical and röntgenological diagnosis) treated with X-rays alone. Tumor much reduced in size. Patient well five years later.

6. H. Giant-cell sarcoma of upper end of femur (clinical and röntgenological diagnosis) treated with X-rays for one year. The tumor steadily increased in size and curettage was performed, revealing very vascular broken-down tumor tissue which resembled giant-cell tumor. The patient grew worse steadily. The tumor extended to ileum. Death occurred in one and one-half years. No evidence of metastases. Histological diagnosis uncertain, due to broken-down condition of tissue removed. Degenerating chondroma (?).

<sup>8</sup> A fuller history of many of these cases can be found in *ANNALS OF SURGERY*, March and April, 1924.

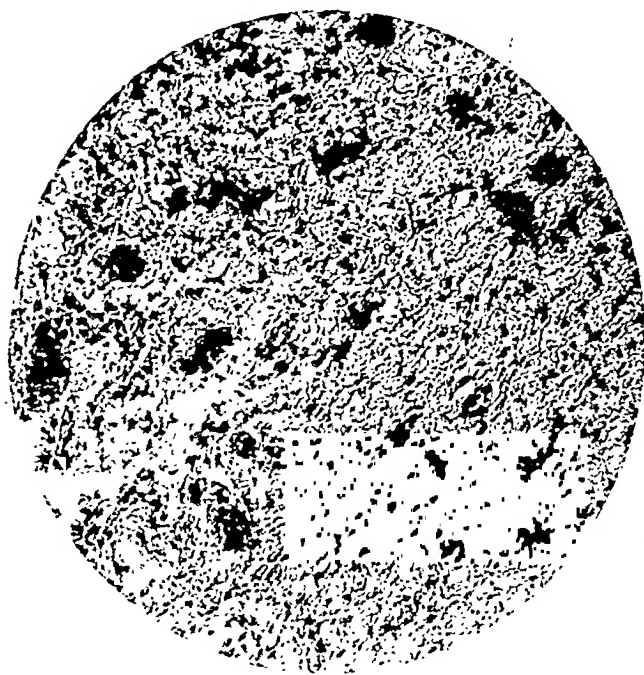


FIG. 17.—Preceding case.

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7. U. Tumor of upper end of ulna, diagnosed as giant-cell sarcoma benign, treated with X-rays for a period of one and one-half years, when metastasis developed to the jaw. This case is reported in Kolodny's review of the Bone Sarcoma Registry as a "typical benign giant-cell tumor." (April No. *Surgery, Gynecology, and Obstetrics*, 1927.)

8. H. Benign giant-cell tumor of lower end of tibia (clinical and röntgenological diagnosis) treated with X-rays alone for a period of four months. The tumor continued to increase in size rapidly, pulmonary metastasis developed, and the patient died in five months. This proved to be a highly malignant osteogenic sarcoma.

9. C. Giant-cell sarcoma of os calcis. Clinical and röntgenological diagnosis was that of benign giant-cell tumor. Patient treated with X-ray alone; well three years later.

10. N. Giant-cell sarcoma of lower end of femur, treated with X-rays alone for a period of eight months. Marked improvement in condition; patient still under treatment. (Case of Doctor Heronstein.)

11. R. Giant-cell sarcoma of radius (clinical and Röntgen-ray diagnosis, treated by Röntgen-ray.

12. H. Giant-cell sarcoma of humerus, treated by Röntgen-ray. Well two years.

13. F. Giant-cell sarcoma of upper end of humerus (clinical and röntgenological diagnosis), treated with X-rays for a

period of one and one-half years. Patient well three years later. In this case the clinical evidence was not as definite as in the other cases and I believe that tuberculosis cannot be ruled out.



FIG. 18.—(Case No.) Giant-cell sarcoma of lower end of femur treated with radium (total 98,406 mc. hours). Patient well five years later. (This patient was treated by Doctor Quick.)

### GROUP II

#### *Cases Treated by Radiation after Biopsy or Curettage*

1. N. Benign giant-cell sarcoma of tibia (clinical, röntgenological and microscopical diagnosis), treated by curettage and radium; 40 millicuries of bare tubes of radium emanations were placed in the cavity of wound after curettage, and left there for forty-eight hours. Slow filling up of cavity; no signs of infection until eight

months later when there was evidence of a recurrence. A second curettage was performed; infection developed; amputation was performed. Pulmonary metastasis developed and the patient died in four months. Published in full by Ewing and Stone.

2. S. Benign giant-cell sarcoma of upper end of tibia (clinical, röntgenological and microscopical diagnosis. Curettage was performed followed by treatment with radium and X-rays. Amputation was performed followed by recurrence in the stump of thigh and extension of disease into pelvis. Death shortly afterwards; no definite pulmonary metastasis could be determined.

3. H. Benign giant-cell sarcoma of upper end of tibia (microscopical diagnosis), treated by curettage, followed by radium (12,000 mc. hours in form of pack). Patient well four years later.



FIG. 19.—Preceding case, two and one-half years after treatment was begun.

4. R. Benign giant-cell sarcoma of upper end of tibia. Curettage and microscopical examination. Treated by radium and X-rays for one year (150,000 mc. hours). Patient in good condition for two years when a pathologic fracture occurred following a slight strain; slow healing; stiff knee. Patient alive and well five years later. Stiff knee.

5. B. Benign giant-cell sarcoma of lower end of femur. Curettage and microscopical examination. Treated by radium and X-rays for one and one-half years after amputation. A small, painful, radium ulcer developed above knee, which it was impossible to heal and which required re-amputation. Patient well five years later.

6. M. Benign giant-cell sarcoma of lower end of femur, treated by curettage followed by X-ray treatment. Case reported in full by

Bancroft in *Clinics of North America*, December, 1921. Four operations performed; finally resection of lower end of radius and ulna. Patient alive but with considerable impairment of function, seven years later. (This patient was not under my care but seen in consultation only.)

7. S. Benign giant-cell sarcoma of lower end of femur (clinical and röntgenological diagnosis confirmed by biopsy), treated by X-rays. Later tumor increased in size; pathological fracture occurred; amputation was performed on account of useless limb. Microscopical diagnosis; malignant central sarcoma. Patient died of metastases six months later.

8. R. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

biopsy; no curettage. Treated by X-ray for two years. Patient well with useful leg, three years later.

9. R. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by biopsy. Treated by X-rays. Patient well four years later.

10. H. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by microscopic examination. Primary treatment consisted of partial resection of condyle. Apparent recurrence developed one and one-half years later. X-ray treatment given for six months. Patient in good health five years after the operation or three and one-half years after the X-ray treatment was given. He is able to get about, with marked limp; has about 45 degrees of motion.

11. K. Benign giant-cell sarcoma of upper end of tibia. Curettage by Dr. Joseph A. Blake in June, 1922. Post-operative treatment at Memorial Hospital; nine treatments from February to May, 1922. Examination in November, 1926, discloses recurrence of pain but no evidence of recurrence (according to röntgenogram); cavity not entirely filled in. Further X-ray treatment ordered. Patient well five years after curettage.

12. B. Benign giant-cell sarcoma of upper end of tibia; curettage. Treated by radium after operation. Case not traced.

13. D. Giant-cell sarcoma of the lower end of the femur; curettage. Microscopical diagnosis by Ewing was that of benign giant-cell tumor. Case not traced.

14. S. Giant-cell sarcoma of femur, treated by curettage and Röntgen-ray, with marked improvement.

15. D. Case of Doctor Quick. Giant-cell sarcoma of femur treated by curettage and bone-graft by Doctor Verdi four years ago. Recurrence. Röntgen-ray diagnosis: giant-cell tumor. Treated by heavy radiation (Röntgen-ray and radium). Patient in good condition one year later.



FIG. 20.—Preceding case, five years after treatment was begun.

### GROUP III

#### *Cases Treated by Surgery Alone (Curettage, Resection or Amputation)*

1. H. Giant-cell sarcoma of radius. Curettage performed by Dr. Russell Hibbs: patient later observed by Doctor Coley. In good health eight years later.

2. S. Giant-cell sarcoma of tibia. Clinical, X-ray and microscopical diagnosis. Amputation performed. Metastasis to the radius developed. Death occurred one and one-half years later.

3. P. Giant-cell sarcoma of tibia, treated by curettage and carbolic acid. Operation performed by Dr. Royal Whitman. Patient well two years later.

4. McG. Giant-cell sarcoma of tibia. Curettage performed by Doctor Coley in 1898. Case not traced beyond one year.

5. H. Giant-cell sarcoma of humerus. Amputation performed. Metastases developed shortly afterwards ending in death.

6. W. Giant-cell sarcoma of tibia. Amputation performed. Death from pulmonary metastases seven years later.

7. P. Giant-cell sarcoma of tibia. Amputation performed by Dr. Charles A. Parker, of Chicago. Patient well several years later.

8. S. Giant-cell sarcoma of femur. Curettage performed. Patient in good health two years later when last traced.

9. Giant-cell sarcoma of femur, treated by curettage and carbolic acid, followed by recurrence. Second curettage and muscle implant. Patient well two and one-half years later.

10. F. Giant- and spindle-cell sarcoma of humerus (giant-cells of epulis type). Death from metastases few months later.

FIG. 21.—December, 1924. Giant-cell sarcoma of femur treated by curettage and radiation. Two years later a fracture of the leg developed following a very slight strain. Patient well at present, with a stiff knee.

11. K. Giant-cell sarcoma of tibia. Treated by curettage and carbolic. Well six months later.

12. Giant-cell sarcoma of radius. Clinical, X-ray and microscopic diagnosis. Resection later recurred in adjacent ulna. Amputation followed by metastases in lung. One year later death.

13. T. Seen in consultation. Giant-cell sarcoma of ulna. Resection performed by Doctor Bloodgood, with implantation of bone. Patient well ten years later.

14. R. Giant-cell and spindle-cell sarcoma of upper end of fibula, operated upon by Doctor Hoguet and myself. The wound was fulgurated with the Keating-Hart apparatus. Gas bacillus gangrene developed three days later necessitating immediate amputation. The patient made a good recovery and was in good health eight years later.

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

15. K. Giant-cell sarcoma of upper end of tibia treated by curettage. Patient remained well for four months when he was lost sight of.

16. S. Giant-cell sarcoma of lower third of femur treated by curettage followed by amputation by Doctor Hartwell. The patient remained well for eleven months and then developed metastases to the iliac glands and lung which proved fatal. This case had two types of giant cell, one of the benign epulis type, one of the malignant type.

### GROUP IV

#### *Cases Treated by Toxins Alone or Toxins and Surgery*

1. D. Central tumor lower end of radius, complete destruction of two and one-half to three inches of bone; bony shell destroyed. Treated with systemic injections of mixed toxins of erysipelas and *Bacillus prodigiosus* for four months. Patient made a complete recovery with full restoration of function and regeneration of bone; well some years later. Bone Sarcoma Registry diagnosis: benign giant-cell tumor.

2. F. Giant-cell sarcoma of lower end of radius, treated by curettage (amputation advised by Dr. Frank Hartley). Patient recovered under six weeks' treatment with toxins; the pathologic fracture reunited, and she is in excellent condition nineteen years later.

3. S. Central tumor of lower end of radius (clinical and röntgenological diagnosis was that of giant-cell sarcoma). Biopsy performed but no curettage. Microscopic diagnosis: giant- and spindle-cell sarcoma. Treated with toxins for six weeks. Patient made a complete recovery and was well when last traced, three years later.

4. McC. Giant-cell sarcoma of lower end of femur, treated by curettage and bismuth paste by another surgeon. Further curettage performed to control infection. Toxins given for several months. Another infection developed one year later necessitating amputation; no tumor found in femur. Patient later died of nephritis.

5. S. Giant-cell sarcoma of lower end of femur. Biopsy without curettage. Toxins given for several months. One year later a pathologic fracture occurred with injury to popliteal artery, necessitating amputation. Patient well ten years later.

6. B. Central tumor of upper end of humerus of rapid development. Imme-



FIG. 22.—Preceding case, March, 1926.

diate amputation performed followed by a short course of toxin treatment. Microscopical diagnosis: giant-cell sarcoma of epulis type. Patient developed pulmonary metastasis and died about a year later.

7. T. Giant-cell sarcoma of lower end of femur, extension. Amputation performed in another hospital. Prophylactic reduction with toxin by Doctor Coley. W six years when last traced.

8. G. Giant- and spindle-cell sarcoma of lower end of femur involving knee joint. Biopsy but no curettage. Amputation advised by Doctor Gibney and myser but refused by patient. Treated with mixed toxins alone. Patient alive and well, with two inches' shortening, twelve and three-quarters years later.

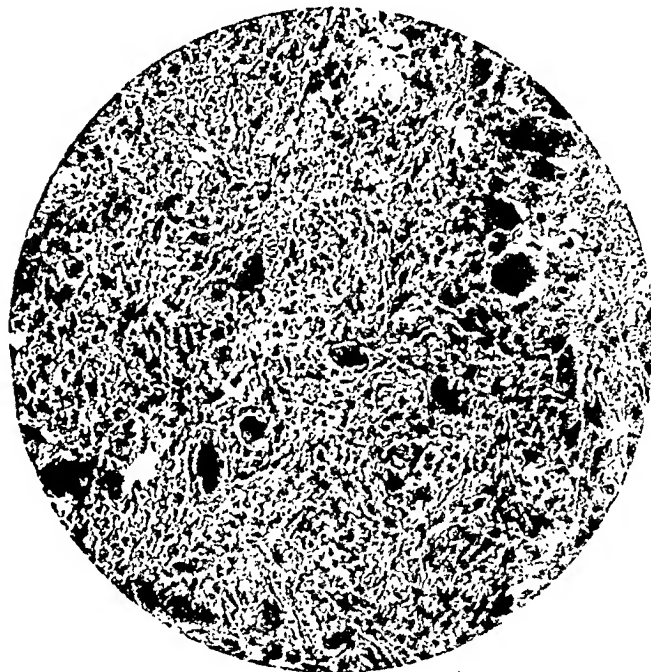


FIG. 23.—Preceding case.

9. Giant-cell sarcoma of femur. Biopsy revealing very large, inoperable tumor. Treated with few doses of toxins but with little effect. Death occurred in few months, undoubtedly, from a highly malignant, osteogenic sarcoma. (Clinical diagnosis in this case, malignant bone tumor.)

10. L. Giant-cell sarcoma of upper end of femur, treated by curettage and prolonged toxins treatment given at Montefiore Home for Incurables under my direction. Patient made a complete recovery and was well eight years later. Microscopic diagnosis made by Prof. T. M. Prudden.

11. C. Giant- and spindle-cell sarcoma of femur, inoperable. Treated with few doses of toxins but with no effect. Patient not traced further. This was, undoubtedly, a malignant osteogenic sarcoma mistaken for a giant-cell sarcoma. Patient undoubtedly died.

12. S. Giant-cell sarcoma of lower end of femur. Curettage followed by toxin treatment. Wound became infected, and knee-joint became involved, necessitating amputation. Patient well ten years later.

13. R. Giant-cell sarcoma of lower end of femur. Biopsy and injections of toxins given for few weeks. Amputation performed followed by prophylactic toxin treatment for several weeks. Patient developed metastases to pelvic bones and lungs, and died three years after amputation. (Clinical diagnosis: highly malignant bone tumor.)

14. G. Very extensive giant-cell sarcoma of dorsal spine, with complete paralysis of bladder, rectum and lower extremities. Patient lost fifty pounds in weight. Treated with mixed toxins alone from February to May, 1902. Rapid and very marked improvement followed; patient able to walk with crutch in September, and with cane in October. Complete recovery took place. Patient married, has three children, and is in excellent health twenty-five years later. He was shown at a conference at the Memorial Hospital, twenty-two years after treatment.

Three other cases treated by toxins after exploratory operation by Dr. H. DeB.



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Barss at the University of Michigan Clinic, are reported in full in my paper on giant-cell sarcoma, March and April, 1924, *ANNALS OF SURGERY*. Limb saved in two cases. All their patients well over five years.

NOTE: Cases 9 and 12 should hardly be included in this group as they were both rapidly growing bone tumors, undoubtedly malignant, and inoperable at the time they came under observation. This paper is based upon a study of primary operable tumors, presumably giant-cell sarcoma.

15. C. Giant-cell sarcoma of tibia, treated by curettage and toxins. Recurrence six months later treated by second and incomplete curettage. Infection developed, necessitating amputation. Patient well six years later.

16. R. Round- and giant-cell sarcoma of upper end of tibia, treated by curettage by Doctor Steinhardt. Patient then referred to me for prophylactic toxin treatment. Well twelve years later.

### GROUP V

#### *Cases Treated with Toxins and Radium or Toxins and X-rays and Radium*

1. S. Giant- and spindle-cell sarcoma of the lower end of the femur with extensive involvement of knee-joint. Amputation advised by every surgeon who had seen patient, including myself, but refused. I did a very extensive curettage, finding upper end of tibia involved by tumor the size of a hen's egg. Cavity was kept clean with Dakin's solution. Toxin treatment begun on fourth post-operative day and continued for three months. Small sinus remaining was treated with radium pack and steel needle (100 mc. radium emanations) left in for three hours. Patient made a complete recovery with no shortening, and was able to walk without perceptible limp. She remained well for eight years and then died of hemorrhages from child birth.

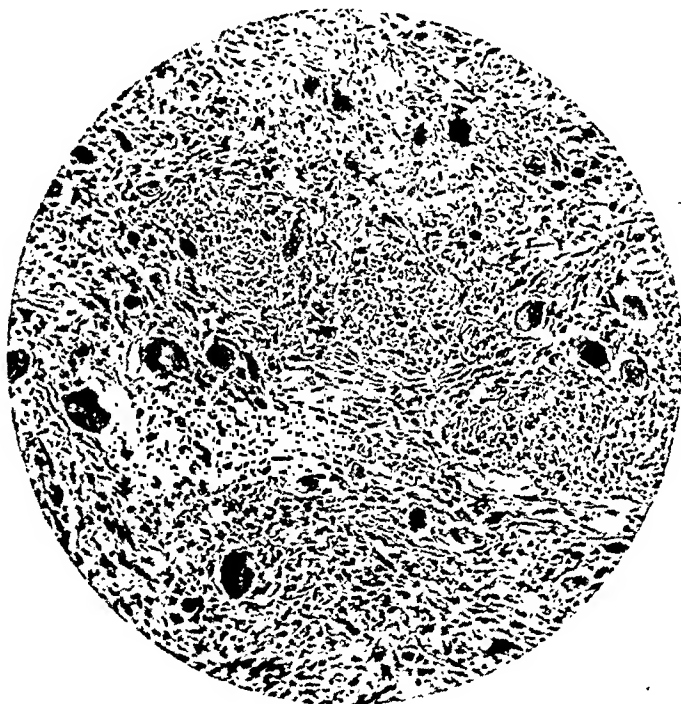


FIG. 24.—Case of Doctors Finch and Gleave, Sheffield, England.

2. F. Giant- and spindle-cell sarcoma of upper end of tibia involving five inches; bone completely destroyed with only a thin shell of cartilage remaining at upper end; treated with curettage and toxins. The destroyed area filled up with healthy granulations. Owing to an attack of "grip" the treatment was suspended, during which interval, the tumor recurred and grew rapidly. Second curettage performed followed by another recurrence. Under prolonged toxins and one radium treatment 10,000 mc. hours, the patient made a good recovery, and is well at present, eleven and one-half years later.

3. F. Benign giant-cell sarcoma of lower end of radius, treated by curettage and carbolic acid. Disease recurred within a few weeks but disappeared under toxin treatment. A second recurrence took place six weeks later. Radium treatment resumed and kept up for three months. The tumor again disappeared, and the patient is free from recurrence six and one-half years later.

4. P. Benign giant-cell sarcoma of humerus. Clinical and Röntgen-ray diagnosis: cyst. Microscopic diagnosis (Ewing): giant-cell sarcoma. Recurrence after curettage. Toxins and radium treatment. Patient in good health with a useful limb, nine years later.

5. K. Giant-cell sarcoma of lower end of tibia, recurrent after two operations; treated by long-continued toxins four months and Röntgen-ray. The patient made a

complete recovery and is well at present, twenty-three years later.

6. G. Giant-cell sarcoma of tibia. Röntgen-ray treatment for two years. Pathologic fracture necessitating amputation. Toxin treatment given as a prophylactic. Patient well two and a half years later.

7. F. Very extensive giant-cell sarcoma of ileum treated with radium in Paris. Disease recurred. At the time of my first observation, the patient had a very large, inoperable tumor, and she was in a very weak and emaciated condition. Under two months' toxin treatment, the tumor softened and broke down. An extensive curettage was performed, following which the patient made a good recovery and remained well for five years, when she developed metastasis, which proved fatal.

8. H. Giant-cell sarcoma of lower end of femur, very cellular. Thorough surgical removal of diseased portion followed by carbolic acid; radiation, and toxin treatment given. At the end of one year there

FIG. 25.—Cellular giant-cell sarcoma of lower end of femur (diagnosis made after curettage in 1924). Patient treated with toxins and X-rays. Some improvement; tumor later increased in size; pathologic fracture occurred. Amputation performed (diagnosis after amputation, benign giant-cell tumor).

was distinct evidence of further extension of disease and gradual increase in bone destruction. A pathologic fracture occurred, necessitating amputation. The patient is free from recurrence one year later. First microscopic examination by Doctor Ewing, whose diagnosis was that of benign giant-cell tumor, rather cellular; prognosis guarded. Second microscopic diagnosis by Doctor Ewing after amputation was that of benign giant-cell tumor.

9. C. Central sarcoma of upper end of humerus following recent fracture. Exploratory operation. Microscopic diagnosis by Doctor Ewing and Doctor Bloodgood was that of benign giant-cell tumor. Treated with toxins and radium. The tumor continued

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to increase in size but later began to decrease and at present, four years later, there is scarcely any evidence remaining. The patient is in good general condition but the arm is practically useless from musculo-spiral paralysis, present when the patient came under my observation.

### CONCLUSIONS

1. Giant-cell sarcoma, or "giant-cell tumor" as it is designated by most pathologists to-day, while in the great majority of cases, a benign or at least only locally malignant lesion, should still be classed as a sarcoma since in certain cases it has all the clinical features of a malignant bone tumor causing death by metastases.
2. In the majority of cases, the clinical and Röntgen-ray evidence will permit a diagnosis of benign giant-cell sarcoma; but in about 20 per cent. of the cases, it is impossible to differentiate the benign from the malignant type without the aid of a microscopic examination.
3. It is not always possible to differentiate the malignant from the benign cases by the clinical, Röntgen-ray and microscopic data.
4. It is possible to cure the majority of benign giant-cell sarcoma by curettage and carbolic acid or zinc chlorid. If the disease recurs, repeated curettage may be necessary. If the destruction of bone is so great that a pathologic fracture develops rendering the limb useless, amputation may be necessary; but not always so, as in a number of cases firm union has later taken place and the patients have remained permanently cured.
5. Largely through the splendid work of Doctor Herendeen, it is now possible to state definitely that giant-cell sarcoma can be cured by radiation. Whether a larger proportion can be cured by this method than by curettage, we are at present unable to determine for lack of a sufficient number of cases treated by radiation that have been followed to end-results.
6. The time required to effect a cure by radiation is considerably longer than that required by operative treatment or by toxins, with or without curettage, and hence the period of disability is prolonged.
7. The chief disadvantage of radiation as a routine, primary method of treatment of giant-cell sarcoma lies in the fact that in a considerable number of cases, the diagnosis of benign giant-cell sarcoma cannot be made from clinical and Röntgen-ray data alone.
8. It is possible to cure benign giant-cell sarcoma, and even far advanced borderline cases (giant- and spindle-cell sarcoma) by injections of the mixed toxins of erysipelas and *Bacillus prodigiosus* without other treatment. Furthermore, it is possible to cure these cases by a combination of toxins and radiation or toxins and curettage.
9. It is possible to cure these cases most rapidly and most certainly by surgery (curettage) followed by toxins. This method requires a much shorter period of disability and is not associated with greater risk; and, in my opinion, it is at present, the method of choice.

# THE SURGICAL TREATMENT OF TUBERCULOUS GLANDS OF THE NECK

AN ANALYSIS OF A SERIES OF 140 CASES

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FROM THE LAHEY CLINIC

WITHIN the last fifteen years, 140 patients have come to us because of troublesome glands in the neck. In 131 cases a clinical diagnosis of tuberculous glands of the neck was made and was verified at operation. In 9 cases the diagnosis was doubtful, but in 7 of these the possibility of tuberculosis was considered. As such cases are illustrative of the difficulties which may occasionally arise in differential diagnosis, they are included in the following discussion.

The literature seems divided between advocates of surgery, of X-ray and of radium in the treatment of tubercular glands of the neck. Because we have a goodly series of cases extending over a sufficient period of years to make a study of end-results worthwhile, we have undertaken a detailed review of our cases, and have made every effort to learn the present condition of each patient in the series, either through personal examination, or questionnaire, hoping that this would throw some light on the advisability and efficacy of surgical treatment.

*Age and Sex.*—Our group of patients shows a definite preponderance of females, there being 93 females and 47 males. As would be expected in a clinic not limited to children's surgery, the age variation of patients was very wide: six patients were less than one year of age, and three were between sixty-one and sixty-five years. The actual age incidence for the entire group is shown in Table I.

TABLE I.  
*Age Incidence in 129 Cases.\**

Age	No. of cases	Age	No. of cases.
Under 1 year.....	6	31 to 35 years.....	5
1 to 5 years.....	17	36 to 40 years.....	3
6 to 10 years.....	17	41 to 45 years.....	3
11 to 15 years.....	9	46 to 50 years.....	3
16 to 20 years.....	17	51 to 55 years.....	9
21 to 25 years.....	15	56 to 60 years.....	2
26 to 30 years.....	20	61 to 65 years.....	3
Under 30.....	101	66 to 70 years.....	0
			28

\* Age not recorded in 11 cases.

*Location.*—The location of the glands was definitely stated in 85 of the case histories. Twelve cases had glands in either the right or left sub-

## TUBERCULOUS GLANDS OF THE NECK

maxillary triangle (6 in each); 10 in the right posterior cervical region, 2 in the left; 25 in the right anterior cervical region; 24 in the left; 1 case had glands limited to the submental region; one showed subclavicular glands, and one patient had a large gland just above the sternal notch. In 9 cases the glands were bilateral, the location not being otherwise stated.

*Duration and Symptoms.*—The condition found on the first examination of these patients showed clearly the possible stages in the progress of the tuberculous condition. Relatively few patients were seen soon after the onset of the disease, when the glands were firm and showed no evidence of necrosis or caseation. In the 100 cases in which the duration of the disease before we saw the patient was recorded, it varied from 3 days to 45 years. In 37 cases the duration was less than a year; in 62, less than 2 years; and in 80, less than 5. Table II shows the actual duration before operation for the 100 cases.

TABLE II.  
*Duration of Glands Before Admission to the Clinic.\**

Time	No. of cases	Time	No. of cases
Several days.....	2	1 year.....	12
2 weeks.....	4	2 years.....	13
3 weeks.....	1	3 years.....	8
4 weeks.....	2	4 years.....	4
1 month.....	1	5 years.....	6
2 months.....	3	6 years.....	3
3 months.....	5	7 years.....	2
4 months.....	2	8 years.....	1
6 months.....	6	9 years.....	0
7 months.....	1	10 years.....	4
8 months.....	1	11 years.....	1
Several months.....	10	12 years.....	1
10 months.....	1	13 years.....	1
<i>Under 1 year</i>	—	17 years.....	2
	39	23 years.....	1
		40 years.....	1
		45 years.....	1
			—
			61

\* Not stated in 40 cases.

From the clinical notes made when the patient was first examined at the time of admission, it seems fair to assume that at least 65 of the 140 cases had either caseation or abscess formation. In addition there were 12 patients who had a discharging sinus in the neck as their chief complaint. This shows clearly that many cases only come to surgery after the tubercular process has gone on for a long time, either with no treatment, or with treatment which fails to eradicate the disease completely, early in its course.

*Previous Infection.*—In 19 cases we could elicit a history of previous infection which seemed definitely related to the occurrence of the glands. In 18 cases there had been preceding tonsillitis. Of these, 14 had had their tonsils and adenoids removed. Only one case, so far as we know, had shown tuberculous tissue in the tonsil on pathologic examination. One case devel-

oped cervical glands following diphtheria; one after influenza; and one after scarlet fever. In 9 cases there had been intermittent subsidence and recurrence of the glands in the neck.

One patient had a definite ulceration of his lower lip which preceded the development of the glands in the sub-maxillary triangle. One stated that his neck swelled after he had received a blow. In one case the tuberculous glands were associated with a multiple colloid adenomatous goitre. Two patients had a history of syphilis.

*Previous Treatment.*—The variety of treatment which had been instituted prior to the patients coming to the Clinic is interesting, and is shown in Table III, for the 45 cases in which it was recorded. Undoubtedly other methods have been employed, of which we have no record.

TABLE III.  
*Previous Treatment in 42 Cases.*

Incision and drainage.....	17
Black salve.....	1
Hygienic treatment.....	1
Excision.....	3
5 previous operations.....	1
Application of ice or iodine (to allay swelling).....	1
3 biopsies by 3 surgeons.....	1
2 previous operations.....	1
1 previous operation.....	3
Alpine lamp.....	2
Tuberculin inoculations.....	2
Massage.....	1
Operation for peritonitis with multiple abscesses.....	1
X-ray treatment.....	7

*Symptoms and Cosmetic Effect.*—The chief symptom which brings the patient with tuberculous glands of the neck to the surgeon is the unsightliness of the tumor. Pain and tenderness were mentioned as an outstanding feature in only 29 cases. Occasionally redness was noted.

*Differential Diagnosis.*—In the differential diagnosis of glands of the neck, we must consider 5 possible lesions: (1) acute non-tuberculous adenitis, (2) Hodgkin's disease, (3) branchial cysts, (4) goitre, and (5) malignancy.

1. *Acute Non-tuberculous Adenitis.*—This is of sudden onset after very definite preceding infection, such as acute tonsillitis, a discharging ear, infected teeth, or a furuncle of the face. The usual course is limited to two to four weeks. Within this time either a frank abscess will develop or the glands will disappear in the majority of cases.

2. *Hodgkin's Disease.*—This resembles tubercular glands of the neck very closely when it first appears as a glandular enlargement in the cervical region. In many cases it is impossible to differentiate the two clinically, and one must wait until microscopic examination of a specimen has been made before the true diagnosis is known. In general, however, we find that in

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Hodgkin's disease glands are often present in the axillæ or groin, as well as in the neck, and the spleen is frequently palpable. Examination of the glands themselves shows them to resemble a bunch of grapes, each gland tending to be distinct from its neighbor. Adhesion to the surrounding structures is less marked in Hodgkin's disease than in tuberculous glands. Caseation and necrosis are, in our experience, unknown.

3. *Branchial cysts* may resemble a large tuberculous abscess very closely. They are usually situated either to the right or left of the midline, lying beneath or mesial to the sternomastoid, most frequently at the level of the upper border of the thyroid cartilage. They often fluctuate in size as does a tuberculous gland. They are painless unless they become infected.

Of the 3 cases occurring in this series, two were thought to be tuberculous glands, and in one the possibility of an infected branchial cyst was considered pre-operatively. The fact that the tumor has been present for many years is one of the few points that may direct one to the correct diagnosis. Of course if a dimple occurs



FIG. 1.—Tubercular glands in right submaxillary triangle. In removing glands in this location the incision must be placed well below the lower border of the mandible in order to avoid the inferior branch of the facial nerve which goes forward to supply the small muscles of the mouth.

over the lower attachment of the sternomastoid, one should immediately suspect the presence of a branchial cyst.

4. It is unusual for *thyroid enlargement* to resemble tuberculous glands of the neck. We have, however, had one patient in whom there was a freely movable, definitely encapsulated tumor just above the suprasternal notch; and about 4 cm. in diameter, which clinically resembled very closely an adenoma of the thyroid. The fact that it did not move with deglutition, however, made us believe that it was not associated with the thyroid gland.

In 2 cases we have found a goitre present with numerous glands on each side of the neck. Clinically we considered one of these to be Hodgkin's disease associated with a goitre, and the other malignancy of the thyroid with enlargement of the cervical glands. Pathologically the first case was found to be leiomyosarcoma with early Hodgkin's disease, while the second case was

simple adenomata of the thyroid with associated tuberculous glands of the neck.

5. When *malignant glands of the neck* occur, secondary to carcinoma of the tongue or jaw, the primary lesion points the way to the correct diagnosis of the cervical enlargement. With sarcoma of the cervical glands, the tumor is distinctly of the type which is characteristic of malignancy. It is, as a rule, firm, adherent, indurated, immovable. It obviously encroaches upon the neighboring structures. There is no division of the mass into individual glands.



FIG. 2.—Tubercular abscess over the middle of the left sternomastoid at about the level where the spinal accessory nerve is crossing the neck to enter the trapezius muscle. Incisions of abscesses in this location must be carefully made to avoid possibility of spinal accessory injury.

In tuberculous glands of the neck, the history is as a rule one of chronicity; pain and tenderness are not remarkable in the early stages; frequently the history will show periods of enlargement and recession. Usually, before abscess formation occurs, the mass is movable and does not appear to be involved in surrounding structures. Although numerous small glands may be felt close to the tumor, these do not have the typical isolated feeling which is characteristic of Hodgkin's disease. Fever is more

common with tuberculous glands than with the other lesions noted. It is, however, true that in diagnosing the enlargement of the cervical glands, there are many cases in which one cannot come to a definite conclusion until a gland has been removed and examined microscopically.

Occasionally in the uncertain cases of cervical glandular enlargement, an X-ray of the chest will show marked enlargement of the mediastinal glands, consistent with Hodgkin's disease, and will in that way be of definite value in making the diagnosis. Usually, however, when glands are present in the neck and there is marked enlargement of the mediastinal glands, there will be such generalized adenopathy that the diagnosis of Hodgkin's disease or lymphoblastoma will readily be suspected by clinical findings alone.

In connection with differential diagnosis it is interesting to consider II



## TUBERCULOUS GLANDS OF THE NECK

of our cases in which clinical diagnosis proved difficult, and to check this clinical diagnosis with the pathologic report on the operative specimen. (Table IV.) It is noted that we had been unable to decide before operation whether the diagnosis should be tuberculous glands or Hodgkin's disease in 5 of these cases. In these 5, the pathological diagnosis showed the presence of Hodgkin's disease in two cases, and of tuberculosis in two cases, while the fifth proved to be carcinoma metastatic from some undiscovered focus.

One patient presented clinically signs of Hodgkin's disease and an adenomatous thyroid; pathologically this was reported as early Hodgkin's disease with lympho-sarcoma. In a second patient we found many glands in each supra-clavicular region associated with an adenomatous thyroid. Clinically we believed the goitre to be malignant with associated glands in the neck. At operation, however, we were surprised to find a large, partly substernal adenomatous thyroid and many tuberculous glands. The goitre and the glands were removed in two operations with a most satisfactory clinical result.

It is of interest to note that in only one case was a definite diagnosis of tuberculous glands made which proved pathologically to be Hodgkin's disease.

TABLE IV.  
*Differential Diagnosis in Eleven Cases*

<i>Clinical diagnosis</i>	<i>Pathologist's report</i>
Case 1. Hodgkin's disease or tuberculous glands.	Hodgkin's disease.
Case 2. 3 biopsies elsewhere, Hodgkin's suggested, clinically Hodgkin's.	Tuberculous lymphadenitis.
Case 3. Tuberculous glands or Hodgkin's.	Tuberculous cervical lymphadenitis.
Case 4. Hodgkin's, sarcoma, or tuberculous glands.	Hodgkin's disease.
Case 5. Possibly Hodgkin's associated with goitre.	Early Hodgkin's; malignant lymphoma.*
Case 6. Tuberculous glands or Hodgkin's disease.	Adenocarcinoma—metastatic.*
Case 7. Carcinoma of thyroid with metastasis or Hodgkin's disease.	Tuberculous glands and adenoma of thyroid.
Case 8. Branchial cyst or tuberculous glands.	No pathological report. Operative diagnosis; broken-down tuberculous gland with pus.
Case 9. Tuberculous glands.	Hodgkin's disease.
Case 10. Tuberculous glands with abscess.	Branchial cyst.
Case 11. Tuberculous glands with abscess.	Branchial cyst with infection.

\* Both of these patients have died.

We are impressed with the fact that we have had three patients with infected branchial cysts which were diagnosed as tuberculous abscesses of the neck. In only one case was the possibility of an infected branchial cyst considered before operation.

*Surgical Procedures.*—One hundred and thirty-eight of the 140 patients in this series were operated on. One patient refused operation, and in one it was not deemed advisable. In 14 of the 138 cases several operations were performed. In some of these incision and drainage were necessary before

excision could be wisely undertaken; in others, subsequent operations were performed at the Clinic for recurrence.

We will first consider the initial operation in the 138 cases. In 31 instances minor operations such as incision and drainage, with curettement or cauterization of the cavity was employed. In 105 cases the glands were excised; in 2, a biopsy alone was performed.

*Incision and Drainage.*—We have had no experience with the puncture of tuberculous abscesses with hypodermic needles and the injection of bismuth paste and other similar preparations into the abscess cavity.

In general our procedure in the presence of an abscessed tuberculous gland or an exceedingly caseous tuberculous gland has been to make an incision over the fluctuant area and to open the abscess cavity widely. The grumous granulation tissue lining the cavity has been curetted thoroughly, and the cavity wall wiped out with full strength tincture of iodine. A small gauze pack has been inserted. We remove this pack be-



FIG. 3.—Unsightly keloid scar formation following the drainage for many months of a tubercular abscess of the cervical glands.

tween three and five days after operation, replacing if need be a small rubber dam drain. Very frequently it has been our experience that these wounds heal rapidly, drainage persisting for only a few days. We have found that X-ray treatment carried on after this operation has been most satisfactory.

When the sinus following the incision and drainage of a tuberculous abscess of the neck fails to heal within a few weeks after operation, it is our belief that the sinus should be carefully dissected and removed. At its base will be found a broken-down gland, and this gland must be eradicated in certain cases before the wound will thoroughly heal. This procedure we found necessary in 14 cases of this series.

*Excision.*—Our practice in regard to complete excision of tuberculous glands of the neck is becoming more conservative every year. Ten years ago, we, in common with other surgeons, performed many extensive and radical dissections of the neck for large masses of tuberculous glands, whether or not more conservative measures had previously been tried. As

## TUBERCULOUS GLANDS OF THE NECK

we have studied our end results in these earlier cases from time to time, we have found that although the tuberculous glands have been satisfactorily removed, the scarring and the possibility of nerve lesions have been such as to indicate extensive operation less frequently than we had formerly believed. In fact, in late years, we have done practically none of the so-called radical dissections for tuberculous glands of the neck.

It is our present opinion that a large mass of tuberculous glands extending from the mastoid well down the jugular vein should receive heliotherapy or X-ray treatment for at least six months, before radical removal is considered. There are

certain malignant cases of tuberculous glands of the neck in which the constitutional reaction from the active tubercular infection is marked and increasing, in which radical interference is definitely indicated in order to stop the progress of the disease. Operation here should be undertaken, but with particular care to preserve the spinal accessory nerve. Cases of this type are becoming much more rare in our experience in recent years, and in a general



FIG. 4.—Unsightly deformity of the neck from atrophy of the sternomastoid muscle, irregular scar and the drainage of an abscess in a recurrent adenitis occurring years after the first operation.

way are in the group of so-called neglected cases who have gone for many months without any adequate treatment, while the disease rapidly progressed.

When a small group of definitely enlarged glands has been present in the neck for two months or over in a patient who has reached the age of five or more years, we believe that their early and complete removal is the safest and best treatment which can be instituted.

Abscesses and caseating glands have been most satisfactorily treated by incision, drainage, and curettage.

We have come to believe that post-operative X-ray treatment in all patients with tuberculous glands of the neck is of definite value. It is of course important that the X-ray treatment shall be given by one who is thoroughly trained in the principles of X-ray therapy. This form of treat-

ment is not indicated, in our opinion, in the presence of a tuberculous abscess until that abscess has been drained. It then hastens healing of the wound.

Tuberculous sinuses of long duration we excise when the dissection is not too extensive and the danger of nerve impairment not too great. If excision is unadvisable we open the sinus widely down to the caseating gland which lies at its base, and curette the entire tract and caseating gland. We then swab the entire area with full strength iodine and close it with a drain or small pack. X-ray treatment hastens the healing of the sinus.

In 33 cases in this series X-ray has been used post-operatively.

*X-ray Treatment.*—In this series of cases, we have used X-ray treatment when a new tuberculous gland formed in the scar of the operation, or in an area close to the original site of infection. In 4 cases of this type it seemed to us to be distinctly helpful. In 8 other cases of recurrent glands following operation, an abscess developed after the X-ray treatment and was incised with eradication of the lesion. In two of these cases we did not feel that the X-ray was of any help.

Dr. L. B. Morrison, of Boston, has carried out most of the X-ray therapy in our patients with tuberculous glands of the neck. He feels that X-ray hastens coagulation necrosis when it is once begun, and in these cases the formation of an abscess followed by incision and drainage with X-ray treatment is an excellent plan of procedure. If there is no necrosis present in the nodes he believes that they will disappear with properly adjusted X-ray treatment. He says, however, that in his experience there are probably 20 per cent. of cases of tuberculous glands of the neck which will not respond to X-ray treatment. There are two possible explanations for these cases in his opinion: (1) That the diagnosis is incorrect, and the patient has not tuberculous glands; and (2) that a secondary infection is present which prevents response to X-ray therapy. When calcification is present in the lymph-nodes, X-ray treatment is not indicated inasmuch as the process is already in a quiescent state and X-ray will not change the pathology.

#### DISCUSSION

The various alternatives to the use of surgery in the treatment of tuberculous glands of the neck are of course well known. One can find the most excellent authority for the exclusive use of hygienic measures; of X-ray therapy; of heliotherapy and the Alpine lamp. It must be borne in mind that tuberculous glands of the neck are rarely fatal, and that the disability is not, as a rule, great. The patient most commonly seeks treatment because of the unsightliness of the lesion, the chief desire in his mind being the reduction of the unsightly tumor and the prevention of a discharging sinus in the neck. In considering, therefore, the method of treatment which we shall employ in any given case, we should bear in mind first that a good cosmetic result is really the first consideration in the treatment. The second consideration of importance in selecting the type of treatment for any individual case is the length of time which treatment will involve. There are many

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patients who can ill afford either the time or expense involved in a satisfactory course of heliotherapy, X-ray therapy, or hygiene, which must needs be prolonged.

Before the patients in this series came to us for surgical treatment, hygienic treatment, so-called, had been carried out exclusively in one case, without improvement; local applications had been used in two cases; Alpine lamp in two; tuberculin injections in two; and X-ray treatment in seven. There were, of course, many of the group who had had previous operations. Seventeen had had repeated incision and drainage of abscesses; three had had previous excisions. In fact, one of the latter had had five previous excisions.

Our experience with *tuberculin treatment* in the Clinic has been extremely limited. Two of the patients in the group had had extensive tuberculin treatment before coming to the Clinic, without resulting cure. We have had no experience with the post-operative use of tuberculin.



FIG. 5.—Right shoulder drop following dissection of right side of neck seven years ago. Note that the fullness of the trapezius muscle is absent on the right side, the shoulder is lower than on the opposite side and is rotated forward. There is no evidence in this case of any further glandular enlargement and it is almost impossible to see the scar of the operation.

*Heliotherapy* in selected cases is undoubtedly very valuable. It must be remembered, however, that a period of six months to two years is needed in the average case of tuberculous glands for this type of treatment to be effective. If this amount of time can be taken, then this method, properly applied and supervised, is well worth consideration.

*X-ray treatment* is highly recommended by many physicians. Desjardins of the Mayo Clinic feels that surgery should no longer be considered the best method of treatment, and asserts that X-ray or radium treatment is distinctly the method of choice. He states that X-ray is preferable to radium in view of the fact that a more uniform dosage to the entire gland-bearing area is possible.

Bowing, also of the Mayo Clinic, says that the simple type of tuberculous adenitis offers the best results from radium treatment, the patient being meanwhile supported by general hygienic and dietary measures. If suppuration is present, curetting or drainage may be necessary. He advises repeating the radium treatments every six weeks until all signs of activity have disappeared.

Knox says that tuberculous glands slowly regress under X-ray treatment, but rarely disappear, and tend to become active again after a while. For this reason he believes it is advisable to remove them surgically after they have become quiescent.

In our experience X-ray treatment has frequently been of the greatest help when combined with surgery. The X-ray tends to make a hyperplastic node grow smaller. If it is not very carefully controlled, however, the hyperplastic node will break down so that absorption of the necrotic material is impossible and an abscess results. In suppurating glands which have been incised and drained, we believe that X-ray hastens the healing of the sinus. X-ray treatment cannot of course be used when skin erosion surrounds the tuberculous sinus; but in a sinus without surrounding skin involvement, X-ray frequently hastens recovery.

Regardless of what general method of treatment is to be adopted, we believe that the *original source of infection* of the glands should be eradicated, if possible. Thus removal of the tonsils and adenoids when indicated, the removal of abscessed teeth, and the eradication of foci of infection anywhere in the mouth, nose, or pharynx is very valuable. Whether this focus of infection should be attended to before the tubercular glands are removed is a mooted point. Excellent authorities advise removal of tonsils and adenoids first, and removal of the tuberculous glands two months later if they are still enlarged. Other authorities recommend the removal of tonsils, adenoids, and glands at one operation. Still others recommend the removal of the tuberculous glands first, and the subsequent removal of tonsils and adenoids. It is our feeling that the infected tonsils should be removed first, and at a later date the tuberculous glands attended to.

Handford states that in any individual case it must be clearly realized that no plan of treatment can insure a cure, and this has been borne out by our experience. Recurrence locally or elsewhere may occur.

*Preservation of Nerves.*—From our study of these patients it has again impressed us that the utmost care must be used in preserving the spinal accessory nerve. The disability and deformity resulting from the injury to the spinal accessory nerve and resulting paralysis of the trapezius or sternomastoid and trapezius is so severe that we wish to place the utmost emphasis upon this point. (Table V.)

The small branch of the facial nerve which lies beneath the mandible to supply the depressor anguli oris muscle is also frequently injured in dissections of the neck. Although the paralysis of this muscle is not disabling, nevertheless the drooping of one corner of the lip is noticeable, and in many cases annoying to the patient.

In 1922, we published a paper in which we called attention to the deformity and disability arising from spinal accessory paralysis after dissections of the neck. Since that time we have been particularly careful to isolate this nerve in all dissections which we carried near its course, and to preserve it at all costs.

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In investigating the end results in the series reported here we find that since our special attention has been directed to this condition as a result of previous study, our operations have tended to become much more conservative. It is most depressing to see girls and young women who were operated

TABLE V.  
*Cases of Nerve Injury*

Date of operation	Case	Spinal accessory injury	Facial nerve injury
1915.....	H.	Present, but not complete. Disability decreasing	
1924.....	R. K.		Although incision was placed low, she had "lip drop".
1918.....	E. G.	Sternomastoid cut. Bloc dissection neck. Nerve seen and preserved. Has paralysis and shoulder drop	
1922.....	W. H.	Nerve cut, though an attempt to save it was made. Shoulder drop	
1919.....	F.		Lip drop. Noticeable, but not disfiguring.
1914.....	E. J.	Nerve dissected out. Paralysis resulted and still persists. Bad shoulder drop	Noticeable lip drop.
1925.....	B. W.	Nerve preserved. Permanent partial sp. acc. paralysis. Shoulder drop	
1913.....	R. M.	Bloc dissection. Shoulder drop. Spinal curvature	
1918.....	T.		Lip drop. Not bad.
1926.....	Le P.		Right lip drop. Not bad.
1923.....	O'B.	Complete shoulder drop. Much disability. Dissection jugular	
1920.....	S.	Dissection jugular. Complete paralysis of trapezius and sternomastoid	
1925.....	M. H.	Spinal accessory severed and sutured. Now no paralysis	
1917.....	W.	Bilateral spinal acc. paralysis. Very bad deformity	
1915.....	P.	Paralysis sternomastoid. Paralysis trapezius improving. Marked atrophy and deformity	Lip drop—deformity diminishing.
1922.....	G.	Nerve preserved at operation. Temporary paralysis of trapezius.	

on many years ago by the bloc dissection method who have complete paralysis of their trapezius with accompanying shoulder drop, rotated scapula, disability of marked degree, pain with attempts at lifting the arm and even in one case curvature of the spine requiring orthopedic treatment.

The trapezius muscle is the chief muscle involved in the raising of the arms from horizontal to the vertical position. With the exception of the rhomboids and the levator anguli scapuli it is the only muscle that fixes the scapula toward the midline. It is to be remembered that the nerve supply to the trapezius muscle rises not only through the spinal accessory nerve, but also through the second, third and fourth cervical nerves; and that these unite within or beneath the sternomastoid to form the so-called "sternomastoid plexus", and then send fibres to the trapezius and levator anguli

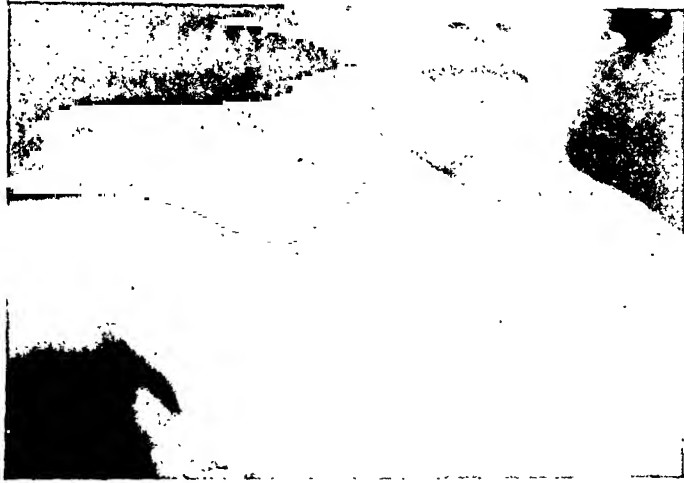


FIG. 6.—Same patient as in Fig. 5 with the right arm elevated to the horizontal. Here the atrophy of the trapezius muscle is very evident.

scapuli. It is quite possible to have a partial paralysis of the trapezius through injury of some of the nerves before they leave the sternomastoid plexus. This is particularly prone to happen when the dissection is carried along the jugular, high in the neck, to the region of the mastoid process. It has been said that if the spinal accessory nerve is in-

jured that paralysis of the trapezius may not be complete, due to secondary innervation which the muscle receives from the upper cervical nerves. We feel very strongly, however, that little if any reliance should be placed upon this possibility, and that every effort should be made to preserve the spinal accessory intact wherever it is encountered. In many cases we have identified the spinal accessory and dissected it throughout its course amongst the tuberculous glands of the neck. Immediately after operation we have observed a trapezius paralysis, which disappeared, however, after a period of three to six months.

In two cases the nerve was cut and at the close of the operation sutured. These two patients have recently been reëxamined, two years after operation, and found to have normal motion in their trapezius muscle. This we consider very valuable evidence that suture of the spinal accessory after it has been cut either by accident or intention should always be done.

Injury to the spinal accessory before it enters the sterno-mastoid muscle will result in a more or less complete paralysis of this muscle. Functionally we have seen no evidence of disability from this lesion. The resulting atrophy of the sterno-mastoid muscle, however, produces a very noticeable deformity of the neck. This was present in three of our cases. In one of these patients it seemed to us that the sterno-hyoid, sterno-thyroid and omo-hyoid muscles had also become markedly atrophied. This added greatly to the



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deformity of the neck. The nerve supply of the infra-hyoid group of muscles arises from the first three cervical nerves and the hypo-glossal trunk through the ansa hypoglossi. (Gray.)

*End Results.*—We have personally reëxamined 43 of the 140 patients in the Clinic within the last month, and have received answers to questionnaires from 40 of those who did not find it possible to come in for reëxamination.

*Patients Reëxamined in 1927.*—Concerning these 43 patients we can report the exact end results. Because of our particular interest in the occurrence of muscle atrophy from nerve injury at the time of operation in neck dissections, we have divided these cases into two groups:

*Group 1.*—Twenty cases which were operated upon five or more years ago. (We published our first paper on nerve lesions in 1922.)

*Group 2.*—Twenty-three cases were operated upon within the last five years.

*Group 1.*—The average lapse of time since operation in this group was nine and a half years. Ten of the patients had a persistent nerve lesion as a result of their operation. (Table V.) This is a high percentage of nerve lesions. In many of these cases, the operative notes state that the spinal accessory nerve was seen and carefully preserved, but in the majority of these patients a very extensive removal of the glands was carried out, frequently by a bloc dissection.

Of the group of 20, 14 have excellent scars; in 5 instances the scar is only fair; and in one it is unsightly.

In 4 cases there had been a recurrence of glands after the operation,

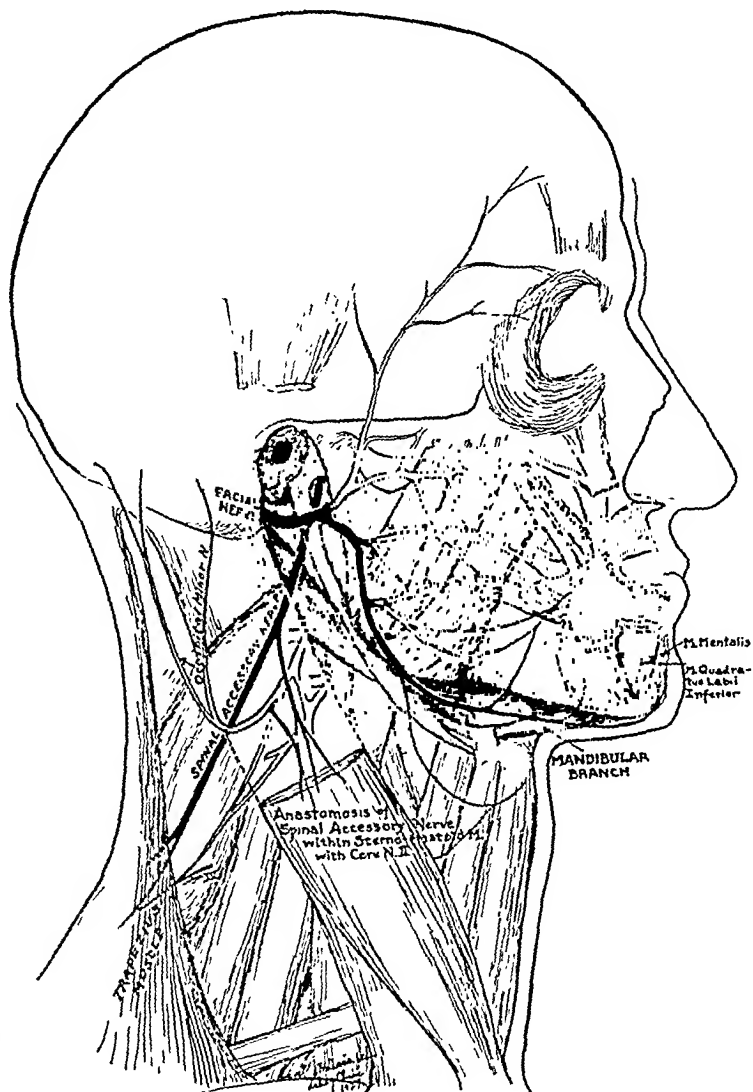


FIG. 7.—Diagram showing the course of the spinal accessory nerve and of the facial nerve. Note the sternomastoid plexus lying within or beneath the sternomastoid muscle in which the branches of the first and third cervical nerves may or may not join with the spinal accessory to supply the trapezius muscle. Note also that the mandibular branch of the facial nerve which supplies the small muscles about the mouth lies beneath the ramus of the mandible for a considerable part of its course.

some of which were controlled by X-ray treatment. Others had required further dissection.

*Group 2.*—Of this group, in which operation was performed within the last five years, that is, since we have given every possible attention to the avoidance of nerve lesions, there has been only one serious lesion post-operatively (two cases of slight lip drop). This occurred in a baby aged thirteen months at the time of operation, who had a very extensive mass of active glands extending along the right jugular vein and seriously affecting her general health. With the exception of the trapezius paralysis which resulted from the operation, she is now in perfect health and has an excellent scar.

Of these 23 cases, the results may be termed perfect as regards condition of the scar, absence of recurrence, and of nerve lesions, in 15 cases. There has been a recurrence of glands, without symptoms, at the site of operation in 5 cases, and recurrence at a new site in 2 cases.

In one patient the results are excellent, except that the scar is slightly keloid.

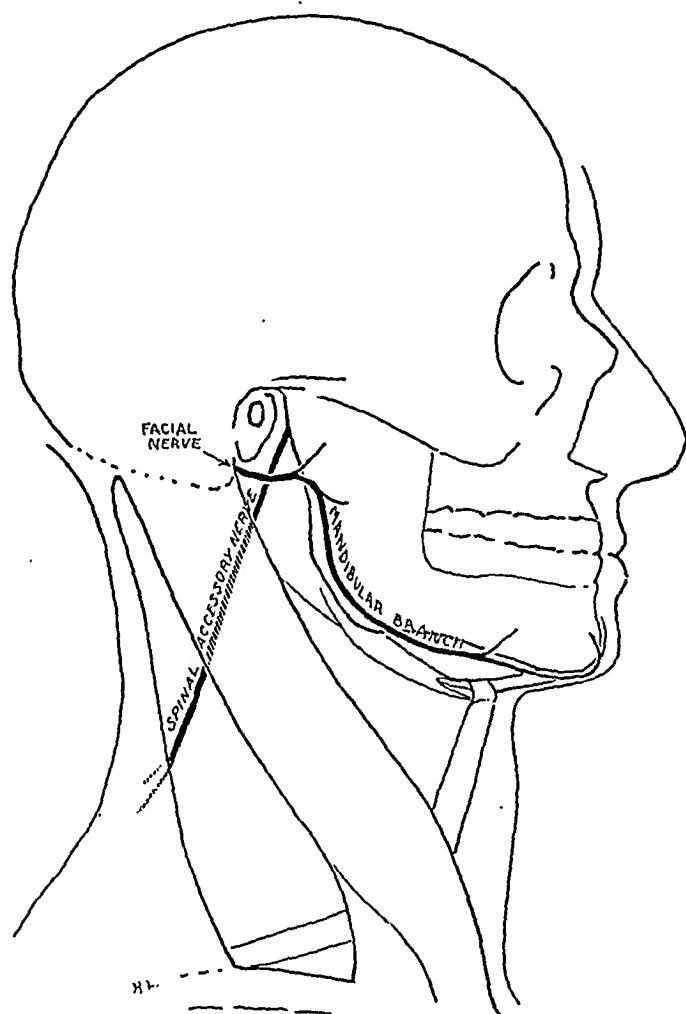


FIG. 8.—Schematic drawing to show the position of the spinal accessory nerve and the mandibular branch of the facial nerve. Incisions for the dissection of glands of the neck must be planned to avoid the possibility of injury of these nerves.

*Answers to Questionnaires.*—The following questionnaire was sent to all patients who did not come in for reëxamination at the time requested: 1. Do you consider yourself (a) cured, (b) partly benefited, (c) not benefited by the operation for tuberculous glands? 2. Have you required further surgery for this trouble since our last operation? 3. Has there been any abscess formation or drainage from the wound? 4. Have any other glands in your neck become swollen or prominent? 5. Have you any difficulty at present which you relate to the operation? 6. What is the present condition of the scar: (a) slightly noticeable, (b) noticeable, (c) ugly? 7. Have you had any evidence of tuberculosis elsewhere in your body. 8. Does any one else

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in your family with whom you are or have been closely associated suffer from tuberculosis in any form?

Twenty-seven patients reported that they considered themselves cured; four "partly benefited". Three patients had died, several years after operation, one of pneumonia, one of acute mania, and one of septicæmia. In one case a nerve lesion was reported, but the patient said that the accompanying deformity was decreasing. In three cases there had been a recurrence of glands. In one of these, the patient stated that she did not consider herself benefited by the operation, but that she had been considerably helped by radium treatment received elsewhere. A second had a subsequent abscess, which is now better, and another patient is having trouble with persistent bronchial colds.

In four cases the scar is reported as noticeable. In all others, it is apparently satisfactory.

### ILLUSTRATIVE CASES

CASE I.—Occasionally a patient has such an active tuberculous infection in the cervical lymph-nodes that her general health is seriously affected. In the case of Mrs. A. A., aged fifty-three years, this factor was the important one in the treatment of her condition.

She had noted a swelling in her neck six months before admission to the Clinic. This increased rapidly in size. She lost weight, had marked increase of fatigability, but otherwise presented no history of disease.

On examination a large mass was found, extending from the mastoid process nearly to the clavicle along the anterior border of the left sternomastoid. Indefinite deep fluctuation was present. Stereoscopic films of the chest showed an abscess in the lower left cervical region, overlying the apex of the lung, and extending down to the mediastinum, with enlargement of the mediastinal glands on the left, probably tuberculous.

An incision was made in the neck along the anterior border of the sternomastoid under ethylene oxygen anæsthesia, and a large mass of glands found, and an abscess containing pus typical of tuberculous infection. The cavity was curetted gently, wiped out with full strength iodine, and closed with a cigarette drain. As soon as the wound was partly healed, Alpine lamp treatment was begun, and has been continued for the past six months.

The general condition of the patient has improved markedly in every way. She has gained weight; her color has improved; and her strength is now returning. As supplementary treatment, the patient was urged to expose her neck as frequently as possible to the direct sunshine. Now, six months after the drainage of the abscess, there is a very small granulating wound which oozes a small amount of caseous material. None of the glands which we previously felt in the neck can be identified.

It is obvious in this type of case that complete and thorough drainage, combined with Alpine lamp treatment, has been of distinct benefit, even though drainage from the wound has of necessity been long. Such a patient, in our opinion, might have done well had it been possible to excise the tuberculous glands soon after their onset. This being impossible in this instance, the conservative measure was of great advantage.

CASE II.—As an example of the results following X-ray treatment, the case of Miss R. H. may be cited. This young woman noted an enlargement of a gland at the left angle of the jaw four years before examination. This had varied in size from time to time. Shortly before she came to the Clinic in 1924, it had become larger and remained so. When we examined her, it was obvious that the gland had broken down and formed an abscess. This was incised and a large amount of pus evacuated. Following this, X-ray treatment was given her by Dr. L. B. Morrison.

Six months later the wound was dry, and we were unable to detect any enlargement of the cervical lymph-nodes. A year later some enlargement of the gland recurred, but this also receded very rapidly under X-ray treatment.

CASE III.—The tendency to recurrence of tubercular glands of the neck after excision is shown in the case of Mr. J. Q. This man was first seen in 1920, when he had an enormous mass of caseous tuberculous glands extending over the posterior triangle of the neck on the left.

This was completely excised, the spinal accessory nerve being carefully preserved throughout its course. The wound healed by first intention.

In 1924, the patient returned with more enlarged glands in the left posterior triangle of the neck. These we excised, and the wound was soundly healed within two weeks of operation.

Pathological examination of the glands each time showed tuberculosis.

This man had had tonsillitis repeatedly and we had advised him to have his tonsils removed, but he neglected to do so.

Five months after the second operation, he returned with an abscessed gland in the left side of the neck, which we incised and drained. X-ray treatment was given before and after this incision, which possibly hastened his recovery.

In 1926, he returned again with several broken down glands on the left side of the neck following another attack of tonsillitis. He then decided to have his tonsils removed. The glands, however, persisted for a time, and it was necessary to excise them. Again the pathological report was tuberculous cervical adenitis.

The patient was last seen four months ago. No glands were palpable in his neck; his throat was clean; and his general health very satisfactory.

It seems to us that in this case recovery was markedly retarded by failure to remove the source of infection, and was only consummated after tonsillectomy in spite of repeated removal of enlarged glands, X-ray treatment, and general hygienic measures.

#### SUMMARY

One hundred and thirty-one cases of tuberculous glands of the neck are discussed in detail, and the differential diagnosis considered in nine other doubtful cases. The end results have been carefully checked in 1927, to determine the advisability of surgical treatment, and the incidence of nerve lesions.

The mortality in the series reported is 0 per cent.

The best results were obtained in cases which came early for treatment, the scar being less noticeable, because extensive resection was not necessary and complete excision was possible. If operation is undertaken before the appearance of sinuses and abscesses, recurrence is rare. If these complications have arisen, the chances of complete cure are not as good.

In certain cases a combination of X-ray treatment and surgery gives excellent results.

For the average patient, who cannot afford the time or expense of prolonged hygienic treatment, surgery seems the method of choice.

Removal of all sources of infection is important. One case is reported in which permanent cure was considerably delayed because of failure to do this.

The incidence of nerve lesions within the last five years, since marked attention has been given to this unfortunate possibility, has been greatly diminished, only one case having had such a lesion.

# TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

A METHOD INVOLVING REMOVING THE FIRST RIB THROUGH THE POSTERIOR TRIANGLE OF THE NECK, AND AT THE SAME TIME, IF DESIRED, AVULSING THE PHRENIC OR POSTERIOR THORACIC NERVE, OR BOTH

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THE modern thoracoplasty, or surgical collapse of the chest, has been a boon to patients suffering from cavernous tuberculosis and suppurative lung conditions. Excluding the spirillum infections, when these conditions do not clear up under medical care, administered with an object of building up general resistance and establishing free oral drainage, artificial pneumothorax is indicated, if possible to attain.

In the suppurative lung conditions artificial pneumothorax is often impractical, because, (1) the diffuse inflammation has made the lung adherent to the chest wall; (2) the rapid formation of pus keeps the cavities distended; (3) bronchial fistulæ are liable to develop; or (4) the abscess may rupture into the pleural cavity and impose an empyema upon a condition that is already exceedingly grave.

In cavernous tuberculosis, in order to collapse the cavities and give the lung absolute rest for a time sufficient to allow the disease to heal, continued artificial pneumothorax is ideal, for it offers hope of later allowing reexpansion of the part of the lung that is free from disease. Very often this is not possible because of fibrous and inflammatory adhesions between the visceral and parietal pleuræ. If these adhesions are small and avascular the intrapleural pneumolysis of Jacobæus, followed by artificial pneumothorax is effective. When the presence of large or vascular adhesions make the Jacobæus method impractical, surgical collapse becomes necessary.

Adequate surgical collapse is impossible without the removal of a section of the first rib. The first rib forms a protective cage for the apex of the lung and forms the support and the line of fixation for the entire side of the thorax. The first rib is held up by the scaleni, anticus and medius.

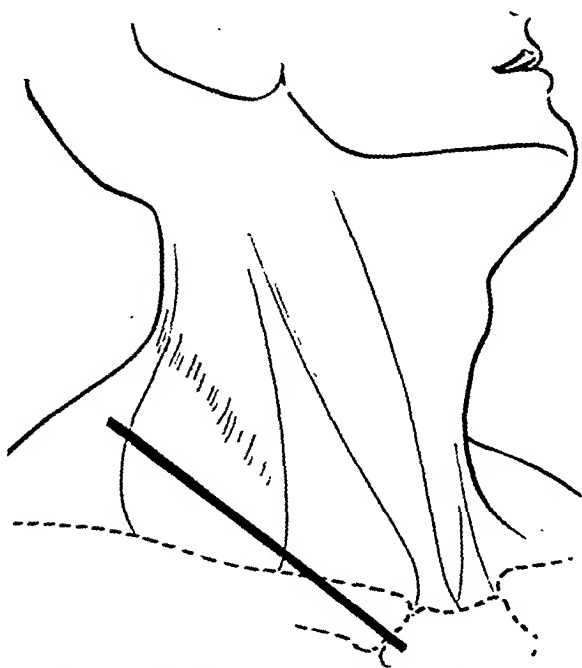


FIG. 1.—Diagram of the external surface of the posterior triangle of the neck, showing the line of incision.

The operations employed for the surgical collapse of the lung provide for the posterior removal of the first rib from below. This procedure has several drawbacks; first, the great trauma to the shoulder and its muscular support produced by the strong retraction which is necessary in elevating the clavicle to reach the posterior portion of this rib; second, the physical difficulty of removing a large enough section of the rib; third, the danger of injuring or cutting the subclavian artery as it arches over the rib immediately anterior to the most desirable location for cutting the rib; fourth,

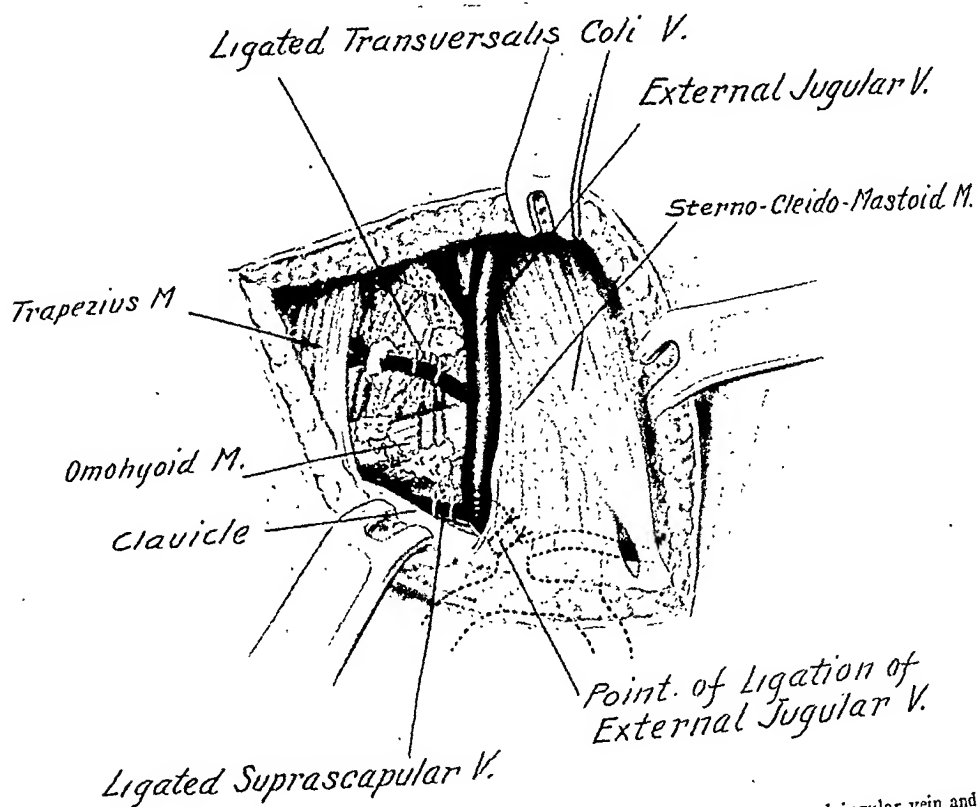


FIG. 2.—The skin and platysma have been retracted, disclosing the external jugular vein and its branches. Points for severance are indicated. The omohyoid muscle is seen through the lymphatic and fatty space behind the sterno-cleido-mastoid muscle.

the blind approach that is necessary and the consequent danger of leaving sharp spicules of bone which may puncture the artery or pleura later; fifth, the extended time that the patient is kept upon the operating table.

Having in mind the objective of overcoming these disadvantages and reducing the morbidity from surgical collapse of the lung, the author has devised an operation that simplifies the removal of the first rib and by gaining the collapse obtained from its removal renders further collapse more easy and diminishes the sum total of operative shock.

The patient lies upon his back on the table with the arms extended down the sides, and a sandbag placed under the shoulder of the involved side. The arm on the involved side is pulled further down the table and fastened while that of the opposite side is relaxed. This lowers the shoulder girdle on the involved side. The incision is made to bisect the angle, the apex of

## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

which is the posterior junction of the sterno-cleido-mastoid muscle and the clavicle, the sides of which are formed by the clavicle and the base of the neck. The incision starts at the trapezius border and ends at the manubrium, and penetrates the skin and platysma. (Fig. 1.) Retraction is made on the sides of the wound. The external jugular vein, coming down the posterior border of the sterno-cleido-mastoid muscle, and ducking behind this muscle, obtrudes itself. (Fig. 2.)

The external jugular vein is dissected downward to a point below where the suprascapular vein branches off posteriorly. This vein is doubly ligated

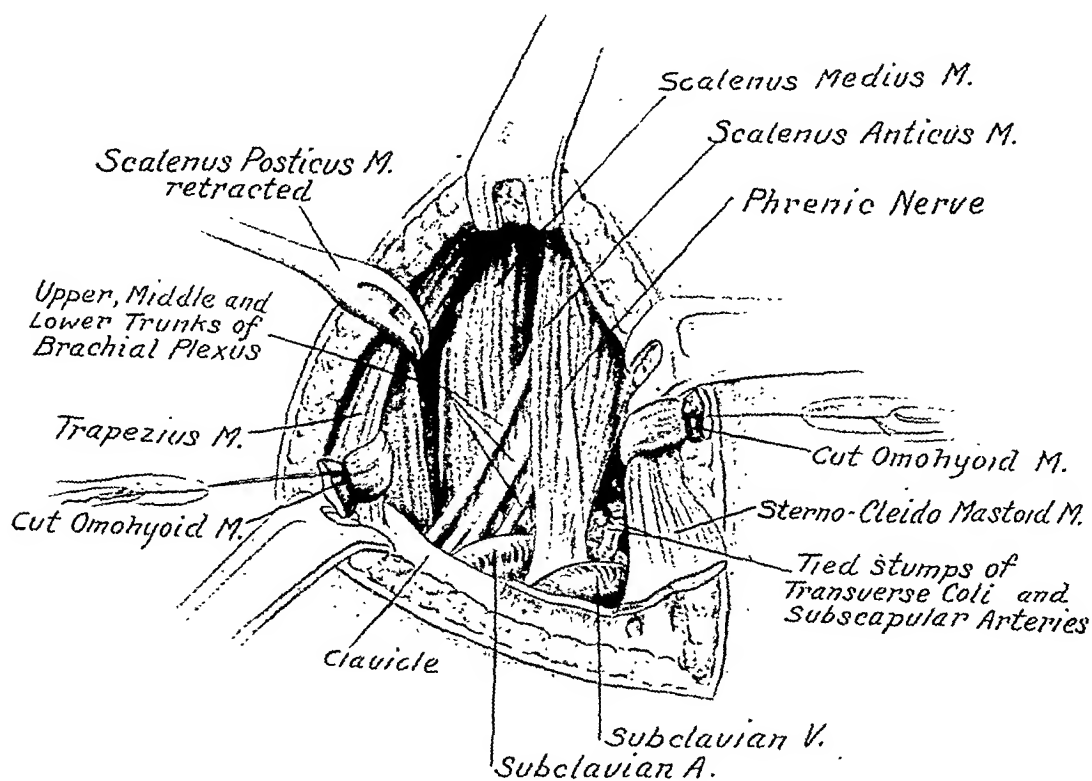


FIG. 3.—The transverse colli and suprascapular arteries have been ligated and cut. The omohyoid has been cut and traction sutures attached to its ends to act as retractors. The lymphatic and fatty tissues have been dissected away, exposing the lateral region of the first rib.

and cut. The external jugular vein is followed upward to its next posterior branch, the transverse collic vein. This is doubly ligated and cut. The external jugular vein is then doubly ligated and cut below the tied stump of the suprascapular vein and above the anterior branching of the anterior jugular vein. The posterior two-thirds of the clavicular portion of the sterno-cleido-mastoid muscle is cut across slightly above its attachment to the clavicle, leaving sufficient muscle and tendon attached to the clavicle for resuturing. The upper severed portion of the sterno-cleido-mastoid muscle with the upper tied stump of the jugular vein is retracted forward. The operator finds himself over a space, usually filled with fat and lymphatic glands. The content of this space is carefully dissected out, keeping watch for two transverse arteries, below, the suprascapular, above, the transverse colli or transverse cervical, both, branches of the thyroid axis which emanates

from the subclavian artery immediately anterior to the scalenus anticus muscle. These are doubly ligated and cut at a point where they cross the scalenus anticus muscle. The peripheral branches of the brachial plexus are disregarded. The omohyoid muscle is doubly ligated and cut where it crosses the scalenus anticus muscle, traction sutures being left on each end in order that these ends may be used for retractors. All fat and glandular tissue is dis-

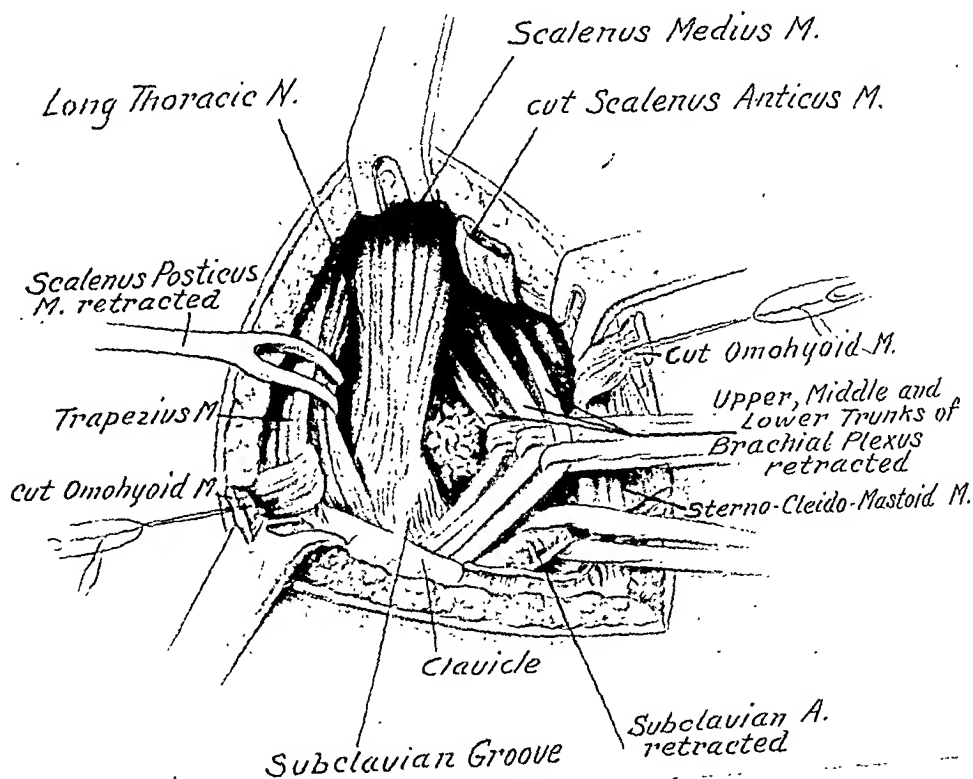


FIG. 4.—The scalenus anticus muscle has been cut and has retracted upward. The phrenic nerve has been avulsed. The subclavian artery has been retracted into the space formerly occupied by the scalenus anticus muscle and the brachial plexus has been retracted forward, uncovering the subclavian groove. The long thoracic nerve is seen coming through the scalenus medius muscle, running down its latero-posterior side and crossing the first rib.

sected away and the overlying structures are retracted backward and forward. No sharp retractors should be used from this time on. (Fig. 3.)

There exposed, from the sterno-cleido-mastoid muscle backward, lie the subclavian vein, arching over the first rib in front of the scalenus anticus muscle attachment to the first rib, the phrenic nerve running down the upper anterior surface of the scalenus anticus muscle and slipping mesially off its anterior side; posterior to the attachment of the scalenus anticus muscle the subclavian artery arching over the rib between the scaleni, anticus and medius, and above the artery, emerging from between these muscles are to be seen the upper middle and lower trunks of the brachial plexus. The operation to this point resembles the preliminary steps in the operation for the removal of cervical rib as described by Adson and Coffey.<sup>1</sup>

Attention is then fixed upon the phrenic nerve. If the diaphragm is to be

<sup>1</sup> ANNALS OF SURGERY, June, 1927, vol. lxxxv, pp. 839-857.



## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

paralyzed the phrenic nerve is cut and the peripheral end is avulsed. If not, the nerve is freed from the muscle so that the muscle, which is soon to be cut, will not pull upon the nerve as the muscle retracts. The scalenus anticus muscle is then severed at its attachment to the first rib. It is well to leave a portion of the muscle attached to later form a bed for the subclavian artery. Immediately within lies the pleura, forward the carotid sheath.

A gauze tape is slipped around the subclavian artery and it is gently

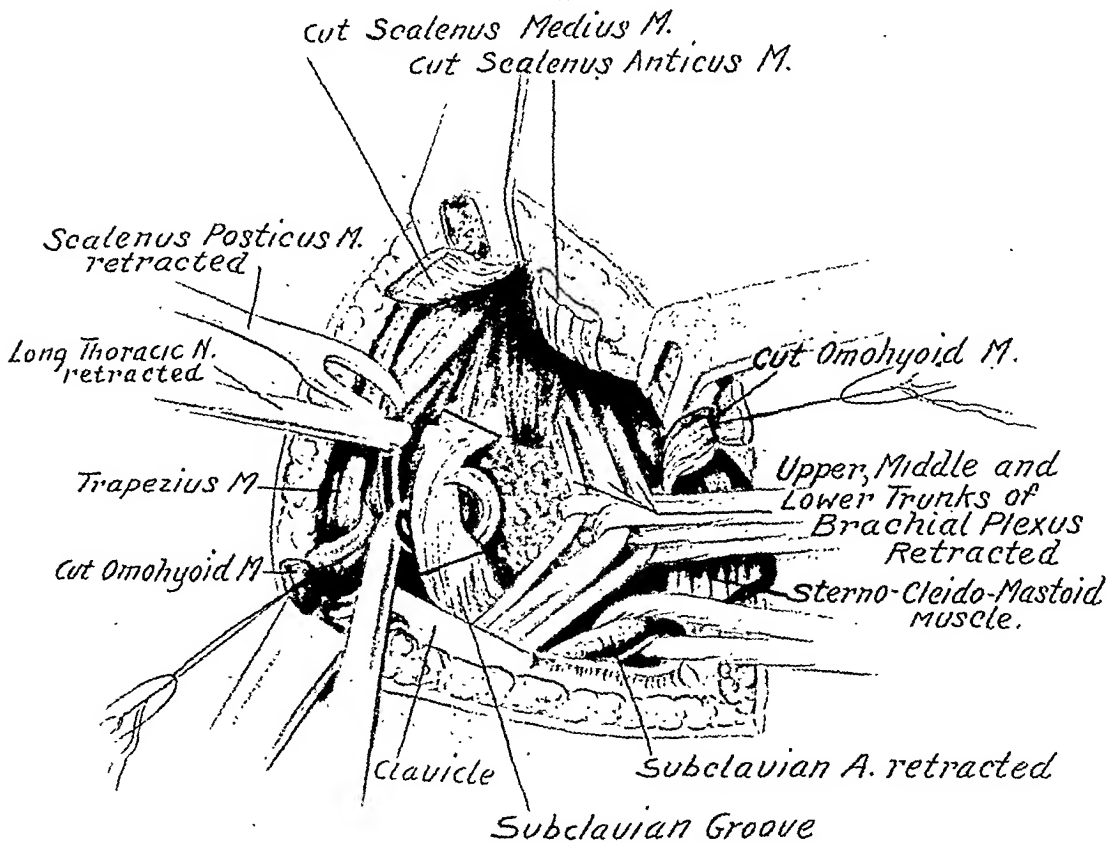


FIG. 5.—The scalenus medius muscle has been cut showing the inward and upward curving of the first rib. The long thoracic nerve is retracted. The lines for cutting the first rib, including a nubbin of the lateral process of the first thoracic vertebra, are indicated. The actual exposure is fully as good as shown here.

retracted forward into the space formerly occupied by scalenus anticus muscle, disclosing the bed of the subclavian arch, the subclavian groove in the first rib. Separate tapes are slipped around each trunk of the brachial plexus and they too are very gently retracted forward. The subclavian groove is fully exposed. (Fig. 4.)

At the superior posterior edge of this groove the rib begins to curve sharply mesially and upward, approaching the transverse process of the first dorsal vertebra. At this point also begins the attachment of the scalenus medius muscle. Because of the mesially directed curve of the rib the scalenus medius attachment to the first rib is nearly at right angles to that of the scalenus anticus. The anterior edges of the trapezius and scalenus posticus, which attaches to the posterior portion of the second rib, are retracted backward, exposing the latero-posterior side of the scalenus medius muscle; the long

thoracic nerve of Bell is located as it runs down the side of the scalenus medius and crosses over the first rib. Whether this nerve is to be avulsed depends upon the opinion of the operator. While the serratus anterior muscle, which this nerve supplies, is not given much credit as a regular muscle of respiration, it is one of the important accessory muscles of respiration and when absolute immobility is desired in the collapse, paralysis of the serratus anterior is an aid. If a large rib resection is to be performed later the costal insertions of this muscle will be destroyed anyway. Very little deformity results from the avulsion of this nerve, particularly in patients who will never be subject to physical labor. A slight clumsiness of the upper extremity is noticed in dogs

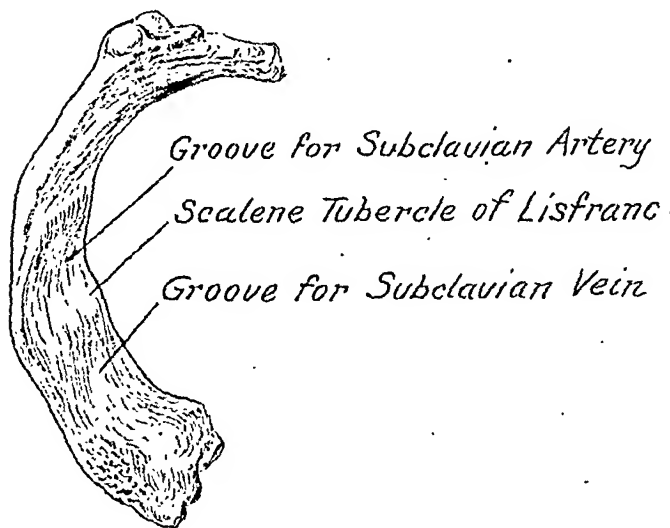


FIG. 6.—The first rib, disarticulated from the costal cartilage and vertebra. The first rib with its cartilage and half of the manubrium forms a semi-hexagon, broken at its divisions into thirds. Its posterior third parallels the lateral plane of the body and bends upward at an angle of approximately 40 degrees.

that have had their long thoracic nerves avulsed. If the nerve is to be avulsed, it is done at this time. If not, the nerve is separated from the muscle and from the first rib where the nerve crosses this rib. Then the scalenus medius muscle is cleanly severed from its attachment to the first rib and the first rib is exposed up to the lateral vertebral process of the first thoracic vertebra. (Fig. 5.)

adherent only to the upper inner narrow margin of the rib is stripped off gently, and the rib is cleaned on all sides with a rib stripper, little attention being paid as to whether or not the periosteum is cleanly removed. The rib is then cut transversely at the upper inner edge of the subclavian groove and at the transverse process of the first dorsal vertebra removing a small nubbin of the transverse process with it. (Fig. 6.)

The pleura, which is adherent only to the upper inner narrow margin of the rib is stripped off gently, and the rib is cleaned on all sides with a rib stripper, little attention being paid as to whether or not the periosteum is cleanly removed. The rib is then cut transversely at the upper inner edge of the subclavian groove and at the transverse process of the first dorsal vertebra removing a small nubbin of the transverse process with it. (Fig. 6.)

The vertebral section of the rib should be made with the points of the cutting instruments pointing downward and backward to prevent possible injury to a low lying vertebral artery. The rib section is removed and the remaining edges are examined and are smoothed off. There is no danger of injuring the spinal accessory nerve in this operation as it runs down the latero-posterior side of the scalenus posticus and is out of the field of the operation.

In this manner an optional one to two inches of the first rib can be removed under direct vision without injury to any structures and the phrenic or long thoracic nerve or both may be avulsed at the same operation. Very little bleeding is encountered, and if any bleeding is present, a gauze drain may be

## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

inserted. The cut ends of the omohyoid muscle are approximated. The severed portion of the sterno-cleido-mastoid muscle is sewed to its previous attachment, a subcuticular suture is put in and the skin closed.

Marked collapse of the lung takes place immediately, so much, indeed, that it is ample for many apical lesions. The patient has not experienced any degree of shock. If the brachial plexus has been handled, respectfully, it is not injured, and if it has received a mild degree of trauma, this will clear up



FIG. 7.—Case No. 32,899. a. Röntgenogram before operation showing cavities in the right upper lobe, and fibrosis and bronchiectasis of the middle and lower lobes. Note large areas of pleural adhesion. b. Röntgenogram of the same case eight days after operation showing the marked collapse from above and below. The apex is collapsed down to the clavicle. This amount of collapse is in itself ample for many apical lesions. The diaphragm has been elevated one and a half costal spaces.

in a short time. The patient should be watched for a week to see the extent of collapse that has been obtained, and future operation, if necessary, planned accordingly.

CASE REPORT.—The practical application of this procedure was demonstrated in Case No. 32,899. Mr. D. J. M., a farmer sixty-seven years of age, with a negative family history, who about eight years previous, following a few days of indisposition, from no apparent reason such as operation or the knowledge of the aspiration of a foreign body, suddenly coughed up a large amount of pussy material, termed by him "corruption." This was followed by an acute illness, but in two weeks' time he was feeling fairly well and within a month had resumed work. Being a very stoical individual, he said that he had been well until the presenting illness appeared. His family stated that he had not been real well in the eight years, being but a silhouette of his former robust self and having frequent colds, considerable productive cough and at times a most offensive breath. Two years before the patient had a right hemiplegia and he had never recovered much use of his right arm. About three and a half months previous to his admission he began coughing and raising a thick yellow sputum. He would

improve and regress until one week before seeking relief when he began to feel very miserable with fever and severe cough and inability to sleep at night for coughing, expectorating as much as a teacup full of pus in a night.

When first seen he was a very feeble, sick old man. Physical examination showed occasional moist râles over the right chest with a central upper region over which breath sounds and tactile and vocal fremitus were absent. White blood-cells, 9000; hæmoglobin, 80 per cent.; red blood-cells, 4,090,000. Wassermann negative. There

were no alarming urinary findings. The röntgenogram showed a large abscess with cavitation in the upper portion of the right lobe with bronchiectasis and much fibrosis. Under the fluoroscope the diaphragm travelled about one-fourth of an inch during respiration and was elevated and nearly fixed. (Fig. 7a.)

The patient and his family were informed of the gravity of his case and were told that little hope was entertained for medical relief, though it should be tried. The patient was hospitalized under rest, tonics, postural drainage and steam. Daily sputum examinations were made. No tuberculosis bacilli or spirillæ were



FIG. 8.—Case No. 32,899. Eight days after operation showing the healed incision and the depression below the clavicle indicating the apical collapse.

ever found. Occasionally staphylococci and streptococci and fibrous tissue were present. His highest daily temperature, 102.8 degrees, on admission showed slight change until the abscess broke on the tenth day. Three days later it was normal and did not go above 99 degrees for fourteen days. His leucocyte count increased to 18,000 and remained high. His sputum increased until the abscess broke and then decreased.

After twenty-four days of observation, his general state of well-being was much improved and his temperature was normal, but his leucocyte count was high and the cavity had not diminished in size. Pneumothorax was not possible because of the obvious presence of large fibrous adhesions. Surgical collapse was necessary.

The first stage operation was performed exactly as described above. The phrenic nerve was avulsed because there was still slight movement of the diaphragm. The patient had a paraplegia on the right side and very little use of the right arm, the long thoracic nerve was also avulsed to get all possible collapse. (Fig. 7b and Fig. 8.)

Marked collapse was immediately evident from inspection. His temperature, never above 100 degrees, was normal in five days and his sputum was decreased one-half. After eight days the wound was entirely healed, the diaphragm was elevated more than one interspace, and fixed, the apex was dropped as much, there was appreciable lateral collapse, and there was absolute immobility of the right side of the chest.

# THE RESULTS OF OPERATION FOR DUODENAL ULCER IN PHYSICIANS\*

BY DONALD C. BALFOUR, M.D.  
OF ROCHESTER, MINN.

THE relative merits of the various operations employed in the surgical treatment of chronic duodenal ulcer continue to be discussed, frequently with a surprising disregard of established facts. It is difficult to explain the great discrepancy in the results of the same operation from different clinics; but the common fault of pointing out only the shortcomings of one operation and emphasizing only the merits of another is in part an explanation of this discrepancy.

My purpose in this paper is to place on record the results of various types of operation performed in the Mayo Clinic on 100 physicians suffering from chronic duodenal ulcer. The average time elapsing since operation is eight and a half years.

This report on the investigations of results in physicians was compiled for several reasons, the two most important of which may be mentioned. First, the cases are well selected, that is, they represent the chronic case in which operation is clearly indicated; a physician with duodenal ulcer usually has tried various forms of medical treatment repeatedly and the frequency of complications is evidence that operative treatment is more likely to be deferred by physicians than by the laymen. For instance, hemorrhage had occurred in 40 per cent. of the cases, whereas in laymen the incidence is only 20 per cent. Obstruction was reported in 32 per cent., whereas in laymen it is 18 per cent. Second, physicians have difficulty in carrying out any post-operative regimen which demands regularity in habits of living and eating. During the period of development of the ulcer and during the post-operative period the physician is unable to protect himself against interruptions in the routine which he would like to follow and which he should follow. The results of surgical treatment under such circumstances should, therefore, be more than a fair test of its value.

The average age of the patients was forty-seven years; the average time since the onset of symptoms was thirteen years. The operations performed were: posterior gastro-enterostomy in 89 per cent., excision alone in 6 per cent., anterior gastro-enterostomy in 3 per cent., and gastroduodenostomy in 2 per cent. (Table I.) These figures show in a rather striking way that the practice in the clinic has been in the past toward conservative operations for duodenal ulcer; and, for the type of duodenal ulcer in which we advise operation, conservative measures are still preferred. Excision alone was usually undertaken for the small duodenal ulcer on the anterior wall, not involving the pylorus, and when the lesion could be excised either with a

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\* Read by title before the American Surgical Association, May 14, 1927.

knife or cautery without encroaching on the pylorus. Such simple excisions were also usually rendered advisable by a difficult cholecystectomy or appendectomy or both. Anterior gastro-enterostomy was performed in three cases in two of which entero-anastomosis was added. Gastroduodenostomy was performed in two cases. It must be said, however, that there did not appear to be as frequent indications for plastic operations on the duodenum and

TABLE I.  
*Types of Operation Employed in 100 Cases*

Primary procedure	Cases	Average age, years	Average length of history, years
Posterior gastro-enterostomy . . .	89	46	13
Excision . . . . .	6	43	7.5
Anterior gastro-enterostomy . . .	3	53	21
Gastroduodenostomy . . . . .	2	37	1.5

pylorus ten years ago as at the present time when about 15 per cent. of operations for duodenal ulcer now are excisions and some type of pyloroplasty or partial duodenectomy.

The results of the various operations are summarized in Table II. Complete relief of symptoms is reported in 87 per cent. of the cases in which posterior gastro-enterostomy was performed. The average time since operation in this group is eight and a half years. There were six cases (6.7 per cent.) in which symptoms recurred to some extent, but such symptoms have

TABLE II.  
*Results According to Type of Operation*

	Cases
Anterior gastro-enterostomy . . . . . Complete relief in three cases (100 per cent.)	3
Gastroduodenostomy . . . . . Complete relief in one case (50 per cent.); second operation in one case	2
Excision . . . . . Complete relief in two cases (33 per cent.); incomplete relief in two cases; second operation in one case, and failure in one	6
Posterior gastro-enterostomy . . . . . Complete relief in seventy-eight cases (87.6 per cent.); incomplete relief in four cases; second operation in three cases, and failure in four.	89

been either corrected by subsequent operation or are controlled by care in diet. Of these six patients one expressed the result as a "50 per cent. cure", and two said that they were "greatly relieved". One patient had a hemorrhage three years following gastro-enterostomy; excision of an angiomatous area of the stomach afforded him complete relief of symptoms and complications since that time. In one case a gastrojejunal ulcer which developed was excised,

## DUODENAL ULCER IN PHYSICIANS

the anastomosis was disconnected and a plastic operation was performed on the pylorus. Symptoms, however, persisted and one year later a posterior Polya was performed following which relief has been complete. Five cases in this group (gastro-enterostomy) may be listed as failures. In one a gastrojejunal ulcer recently necessitated operation. In another, recurrence of symptoms has suggested gastrojejunal ulcer; this has not been confirmed by examination since the patient is able to control the symptoms by diet. One patient has had symptoms which he attributes to gall-bladder disease. In one case, in which a large mass found at the pylorus at the time of the first operation was thought to be a duodenal ulcer, the patient returned to the clinic three years afterward with what was considered to be an inoperable cancer of the stomach. If this proves to be correct, the primary lesion was in all probability carcinomatous gastric ulcer rather than duodenal ulcer. One patient reported that he had had no relief whatever since his operation.

If we, therefore, consider the entire group of cases in which gastro-enterostomy was performed, including the two in which operation has been performed subsequently, we find that in 90 per cent. the symptoms are completely relieved, and in 5 per cent. they are greatly relieved; in 5 per cent. symptoms at the present time are sufficiently troublesome to indicate that the operation was a failure, although in three cases the symptoms are apparently due to conditions other than ulcer.

Of the group in which excision was performed results were not as satisfactory. In two of the six cases results were perfect. In one hemorrhage recurred until gastro-enterostomy was performed and symptoms were completely relieved. Two patients reported symptoms suggestive of gall-bladder disease, and one reported his operation as a failure.

Of the group in which gastroduodenostomy was performed a good result was attained in one, and in the other, a second operation was performed (partial gastric exclusion after the method of Devine) with complete relief of symptoms. In the group of three patients in which anterior gastro-enterostomy was performed, combined in two with entero-anastomosis, all the patients reported perfect results without any qualifications.

If the results of these various types of operation are summarized it is found that, in eighty-four of the 100 cases, results can be classified as completely satisfactory. Many physicians have apparently found it a wise precaution to follow a regular habit of living, to avoid over-fatigue and never to indulge in larger meals at longer intervals. One physician said that he was free of his ulcer symptoms but that he exercised care in his diet; he observed, however, that this was no more than any other person would do. Some of the statements by physicians were almost extravagant expressions of appreciation. The good effects of the operation had been reflected, not only in their own health, but in the peace and contentment of the family.

In six of the 100 cases relief has been incomplete. However, in all of these the patients considered that the operation had been worth while, so that in a total of 90 per cent. the operation may be classed as successful.

In five of the 100 cases secondary operation has been performed (Table III), in two for recurring hemorrhage (in one after excision and in one after posterior gastro-enterostomy); in one for reactivation of the ulcer after gastroduodenostomy, and in two for gastrojejunal ulcer. In three of these there has been no return of symptoms or hemorrhage since the operation and

TABLE III.  
*Subsequent Operations*

Primary operation	Reason for second operation	Second operation	Third operation	Final results
Posterior gastro-enterostomy	Gastrojejunal ulcer and recurring duodenal ulcer	Excision for gastrojejunal ulcer; cut off gastro-enterostomy; knife excision of duodenal ulcer four years later	One year later a posterior Polya; partial duodenectomy for gastric ulcer	Excellent.
	Melena and hæmatemesis	Excision of angiomatous area of wall of stomach three years later		Excellent.
	Gastrojejunal ulcer	Excision of ulcer, disconnected gastro-enterostomy; posterior Polya thirteen years later		Relief.
Gastro-duodenostomy	Recurring duodenal ulcer	Partial gastrectomy, exclusion (Devine type) eight years later		Marked improvement.
Cautery excision	Hemorrhage	Gastro-enterostomy (elsewhere)		Almost complete relief.

in one, operation has been performed so recently that a good result can only be anticipated.

Five of the physicians report persistence of symptoms of such a character that the operative treatment must be classified as a complete failure. Two say that the operation has given them no relief, and one patient, as we have already pointed out, considers his symptoms due to gall-bladder disease. In one case a gastrojejunal ulcer is suspected, but it cannot be proved and the patient is able to control symptoms by a strict dietary regimen. In one, inoperable carcinoma of the stomach has been diagnosed.

If we estimate the results from the standpoint of what can be accomplished by a policy of conservative operation for duodenal ulcer followed by a secondary operation if symptoms recur, the present condition of the patients demonstrates that the result of conservative measures is satisfactory in 93 per cent. The source of this information seems to establish the fact that a conservative attitude toward the treatment of duodenal ulcer is sound.



## LATE RESULTS OF OPERATION FOR CARCINOMA OF THE BREAST\*

BY WILLIAM CRAWFORD WHITE, M.D.  
OF NEW YORK, N. Y.

IN 1922, a paper was read before this society by the late Dr. Charles H. Peck and the writer on tumors of the breast.<sup>1</sup> In that paper we had some information on the five-year operative results in cancer of the breast. It has seemed to me worth while to extend this period for another five years and to review The Roosevelt Hospital cases for the period January 1, 1912, to December 31, 1921, inclusive.

During this period the usual procedure has been a "radical" operation. This has consisted in the removal of the breast, thoracic portion of the pectoralis major, and adjacent axillary contents. The pectoralis minor has been left *in situ*. Special attention has not been paid to the fascia of the rectus abdominis. The amount of skin removed has been moderate in extent. It has rarely been necessary to graft skin. Dry gangrene of the skin edge has been infrequent. The line of incision has been oblique or transverse. The operator made the incision that seemed best adapted to the particular case. The dissection of the skin more and more followed the suggestion of Sampson Handley to remove a large area of subcutaneous fat, but it never has been as thorough a removal of subcutaneous fat as that practiced by some operators. For that reason I think that the information may be of value as a report on the moderate operation.

It has been felt that cases with supraclavicular node involvement were not operable. We had not adopted the practice of Lee<sup>2</sup> in considering a fulness of the supraclavicular region as sufficient indication of inoperability. Nevertheless there are many cases in this group that would not be operated upon now, for I feel that in the earlier years, cases which were not operable were subjected to the knife. Since we have made a practice of taking röntgenograms of the chest, spine, and pelvis before operation, we have eliminated additional cases, but the röntgenogram does not necessarily discover the early bone metastasis. Within the past year the writer had a negative report before operation, yet six weeks later definite Röntgen evidence of metastases to the pelvic bones was present.

Our early cases made little use of radiation before or after operation. Gradually there has developed an increased use of deep X-ray therapy after operation, with practically none before operation. It has been the policy to operate whenever the diagnosis of breast tumor has been made.

It will be noted that these cases may be considered as a group which has not had much radiation. It is true that many have had extensive use of X-ray and radium after recurrences have been noted, but as any case in this

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\* Read before the New York Surgical Society, May 11, 1927.

series, that has had a recurrence has been classified with the dead, the factor of increase in length of life after recurrence under radiation has not entered into these statistics. That can more adequately be discovered in such a clinic as that of the Memorial Hospital.<sup>3</sup>

These patients have been both private and ward. The majority of those followed have been private. In recent years under the improved follow-up system we have found no material difference in the end results than what might be anticipated at the operation. The proportion of private patients

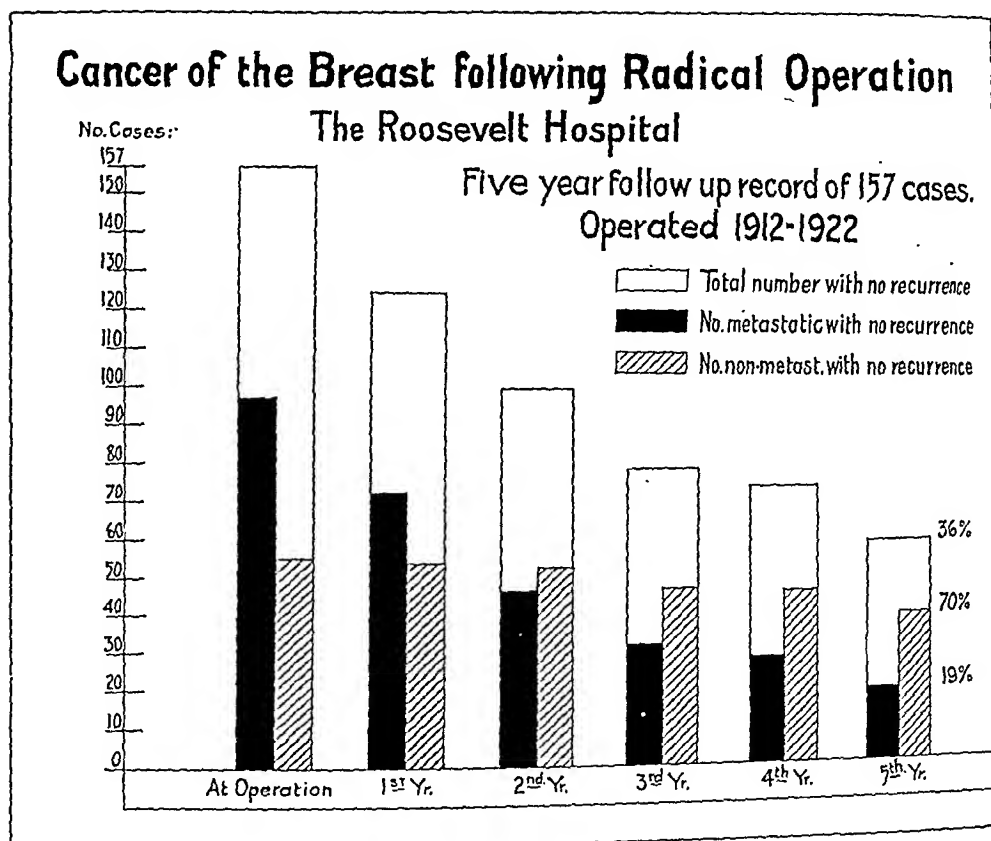


FIG. 1.

without axillary metastases is much greater than in the ward cases. This seems to be due to greater education and knowledge of the potential dangers of tumor in the breast. More and more patients now present themselves for operations on lumps in the breast, which later prove to be benign. Hence the number of early cases of cancer undergoing surgical treatment is increasing.

Local excision with immediate frozen section has been the practice in the doubtful cases. This has not had an appreciable harmful effect, in our judgment, and it has saved many from needless mutilation. It is our confirmed observation that in the early cases it is very often impossible to make a definite diagnosis before local excision. We prefer to tell the patient this. We make a local exploratory excision, with permission to go ahead at the same operation to do a radical procedure, when the frozen section indicates cancer.

The operations have been performed by the attending surgical staff on

# LATE RESULTS OF OPERATIONS FOR BREAST CANCER

duty during this ten-year period. I feel that information gained from such a collection gives a better idea of a good average result than that gathered from the work of one operator. I have been present at most of the operations and have had an opportunity to study the tissue and the microscopic sections. In preparing this paper a reëxamination of the sections has been made and we have excluded a number about which there might be debate as to their malignancy; so I feel that the error of including benign tumors has been reduced to a minimum.

We have late results on 157 cases. There were five operative deaths. At the end of a five-year period 36 per cent. of the 157 were alive and well. I have separated these cases into two groups, those with axillary metastases and those without axillary metastases, after first deducting the operative deaths. Nineteen per cent. of the metastatic cases were alive and well and 70 per cent. of the non-metastatic.

I have made a subdivision to include the five-year period, January 1, 1912, to January 1, 1917. There were 61 cases with 2 operative deaths. We traced the other 59. This group we followed for ten years at least. Ten per cent. of the 40 cases with axillary metastases were alive at the end of ten years; 57 per cent. of the 19 non-metastatic were alive at the end of ten years. This made a total of 59 cases traced with two operative deaths. Fifteen (24 per cent.) of the whole group were alive and free from recurrence at the end of ten years. It is interesting to note from the chart how sharp the rate is at first and then how small the mortality after the first three years.

A number of five-year results after radical operation have been reported.

	Cases	Cures %
Greenough and Simmons <sup>4</sup> (Massachusetts General Hospital).....	69	32
Lee and Cornell <sup>2</sup> (New York Hospital) .....	75	15
Sistrunk and MacCarty <sup>6</sup> (Mayo Clinic) .....	218	36
Moschcowitz, <i>et al.</i> <sup>6</sup> (Mt. Sinai Hospital) .....	89	34
White (The Roosevelt Hospital) .....	157	36

A similar analysis of freedom from recurrence over a five-year period in cases that had no axillary lymph-node metastases has been made by the following:

	Cases	Cures %
Greenough and Simmons <sup>4</sup> (Massachusetts General Hospital).....	16	56
Sistrunk and MacCarty <sup>5</sup> (Mayo Clinic) .....	86	63
White (The Roosevelt Hospital) .....	55	70

I have accurate pathological information as to the site of recurrence in 88 cases. In that group there have been 32 with local or skin recurrence, or 36 per cent. This percentage should not be so high. It is to be remembered that this is the result of not practicing extensive excision of the skin with secondary skin graft. Greenough<sup>4</sup> states that he skin grafts after one-third of his radical operations. This group undoubtedly includes some cases that would now be considered inoperable. In this group there has been a moderate attempt to follow Handley's<sup>8</sup> teachings in regard to the removal of subcu-

taneous fat. It must be remembered that a late skin recurrence (I have noted one as long as sixteen years after operation) may be the result of growth outward from a primary metastasis that had been between the ribs and not removed at the primary operation. Nevertheless I believe that our results teach us that Handley's teachings in regard to the removal of subcutaneous fat should be carefully followed, and that a certain proportion, perhaps not as high as 33 per cent., will require skin graft because of the large mass of removed skin.

Of this group of 88 recurrences, eleven had definite recurrence in the liver

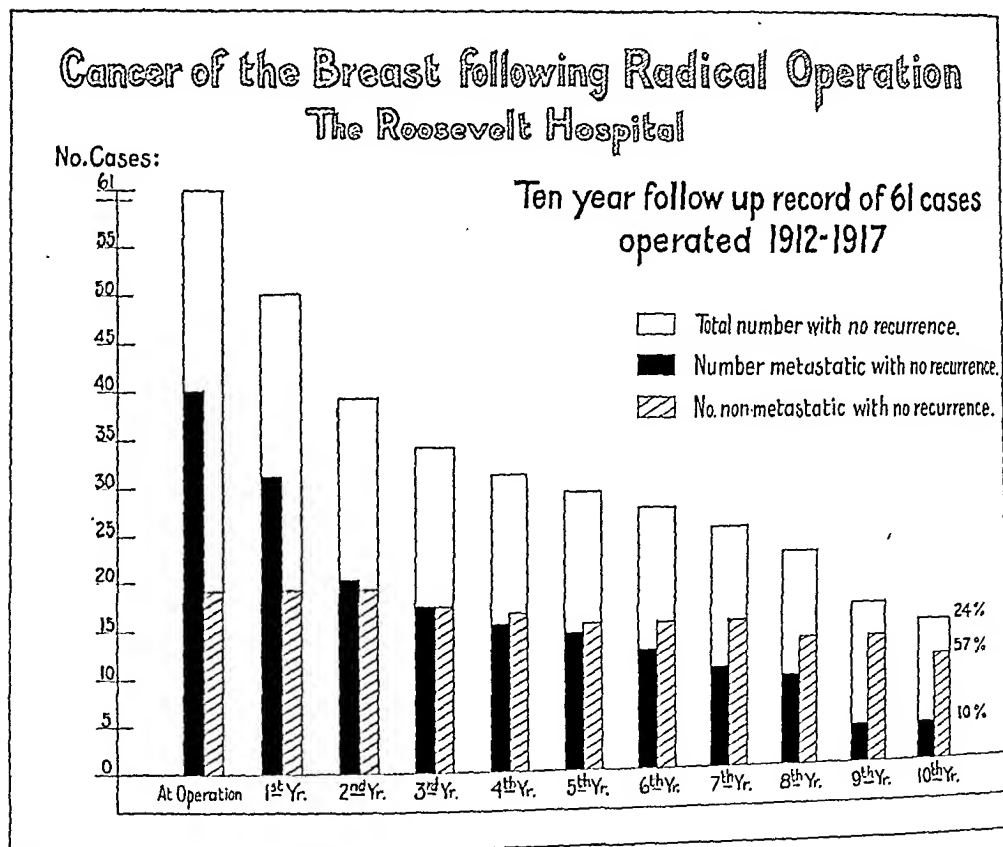


FIG. 2.

or 12½ per cent. This would seem to be rather low when one considers that we did not pay especial attention to an excision of the fascia over the upper end of the recti abdominis.

Sistrunk and MacCarty have suggested that the relative malignancy of the cancer of the breast may be discovered by a study of (a) the cellular differentiation, (b) the lymphocytic infiltration, (c) the fibrosis and (d) the hyalinization. We have not been able to verify their findings in a study of our cases.

A study was made of 100 cases taken here and there from our cabinet. We classified these into one of three groups—low, medium and high malignancy. We followed the description of Dr. Robert Greenough.<sup>7</sup> We find that 69 of our cases were placed in the medium group and we feel that it

## LATE RESULTS OF OPERATIONS FOR BREAST CANCER

makes too large a group, but from a study of the slides we do not see how we could rearrange the group. We feel that more information can be obtained from the two other groups which you will note to be small. In other words, there are definite cases that with Greenough's classification give us considerable information.

### ANALYSIS OF ONE HUNDRED CASES

#### Class I—Low Malignancy

18 cases—14; five-year cures—66%.

	Cases	Cures	Per cent.
A Group (axillary nodes not involved).....	12	11	91
B Group (axillary nodes involved).....	6	3	50

#### Class II—Medium Malignancy

69 cases—33; five-year cures—47%.

	Cases	Cures	Per cent.
A Group (axillary nodes not involved).....	25	22	88
B Group (axillary nodes involved) .....	44	11	25

#### Class III—High Malignancy

13 cases—no cures—no per cent.

	Cases	Cures
A Group (axillary nodes not involved) .....	2	0
B Group (axillary nodes involved).....	11	0

Greenough<sup>7</sup> analyzed 73 cases and he divided his cases into 19 low malignancy with 68 per cent. cures; 33 medium malignancy with 33 per cent. cures; and 21 high malignancy with no cures. Roughly there is a similarity of our findings to his. In this analysis, I had the help and advice of Dr. Charles W. Lester, our Surgical Pathologist. We discussed and reached agreement on slides on which we had independently made opinions.

### CASES 1912-1917

There were 61 cases with two operative deaths.

59 cases were followed for a ten-year period. Of these, 40 had axillary metastases and 19 had no axillary metastases.

	Total	Meta.	Non-metastatic
Free from recurrence at the end of one year.....	50	31	19
two years .....	39	20	19
three years .....	34	17	17
four years .....	31	15	16
five years .....	29	14	15
six years .....	27	12	15
seven years .....	25	10	15
eight years .....	22	9	13
nine years .....	17	4	13
ten years .....	15	4	11

15 out of 61 cases free from recurrence at the end of ten years—24%.

4 out of 40 metastatic cases—10%.

11 out of 19 cases without axillary metastases free from recurrence at the end of ten years—57%.

Of this group there were in addition 40 lost cases.

# WILLIAM CRAWFORD WHITE

## COMBINED CASES 1912-1922

Total of 157 cases, with five operative deaths.

152 cases followed over five years. Of these 97 had metastases to the axilla and 55 did not have metastases to the axilla.

	Total	Metastatic	Non-metastatic
Free from recurrence at the end of one year.....	125	72	53
two years .....	99	47	52
three years .....	77	31	46
four years .....	73	28	45
five years .....	58	19	39

58 out of 157 cases free from recurrence at the end of five years—36%.

19 out of 97 metastatic cases followed free from recurrence—19%.

39 out of 55 non-metastatic cases free from recurrence at the end of 5 years—70%.

Of this group there were in addition 56 cases which had been lost.

## CONCLUSIONS

The removal of the pectoralis minor does not seem to be an essential part of the operation. While the removal of the fascia over the upper part of the recti is desirable, it is not an important part of the procedure.

A wide excision of the skin is not necessary, but on the other hand, an effort to avoid skin graft at the risk of skin recurrence is poor judgment. A wide skin excision can be partly avoided by the careful subcutaneous fat dissection.

Definite metastases in the supraclavicular region are a contra-indication to operation, as is also large extension to the axilla. A palliative operation may be justified for the mental effect on the patient, but not from the point of increasing length of life. It may also be worth while to prevent the annoyance of a sloughing ulcer.

It is fair to believe that of all operable cases, 30 to 35 per cent. are free from recurrence at the end of five years. If we take only the cases that are free from axillary metastases, 60 to 65 per cent. are free from recurrence at the end of five years.

Our ten-year group of 61 cases indicates that 24 per cent. are free from recurrence at the end of ten years. Of the cases free from axillary metastases about 50 per cent. may expect to be free from recurrence.

A study of the cancer cell in relation to its adenomatous formation, secretion, size variation, nuclear changes and hyperchromatosis gives one a clue as to the relative malignancy of the particular cancer of the breast investigated. It is not as certain as the help derived from a study of the epithelioma of the lip.

I do not believe radiation before operation is proved of value. Radiation after operation has not lowered the mortality in the second half of our ten-year group. Nevertheless I have not abandoned the belief that it may do some good and for the present will continue to advise its use after operation.

I desire to render my thanks to the Attending Surgeons and Staff of The Roosevelt Hospital for their help in preparing this paper.

# LATE RESULTS OF OPERATIONS FOR BREAST CANCER

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# TREATMENT OF CARBUNCLES

A COMPARISON OF FOUR DIFFERENT METHODS

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THE methods for the treatment of carbuncles are legion, which emphasizes the truth that, whether based on scientific principle or on empiricism, the end results are produced by the art rather than by the science of surgery.

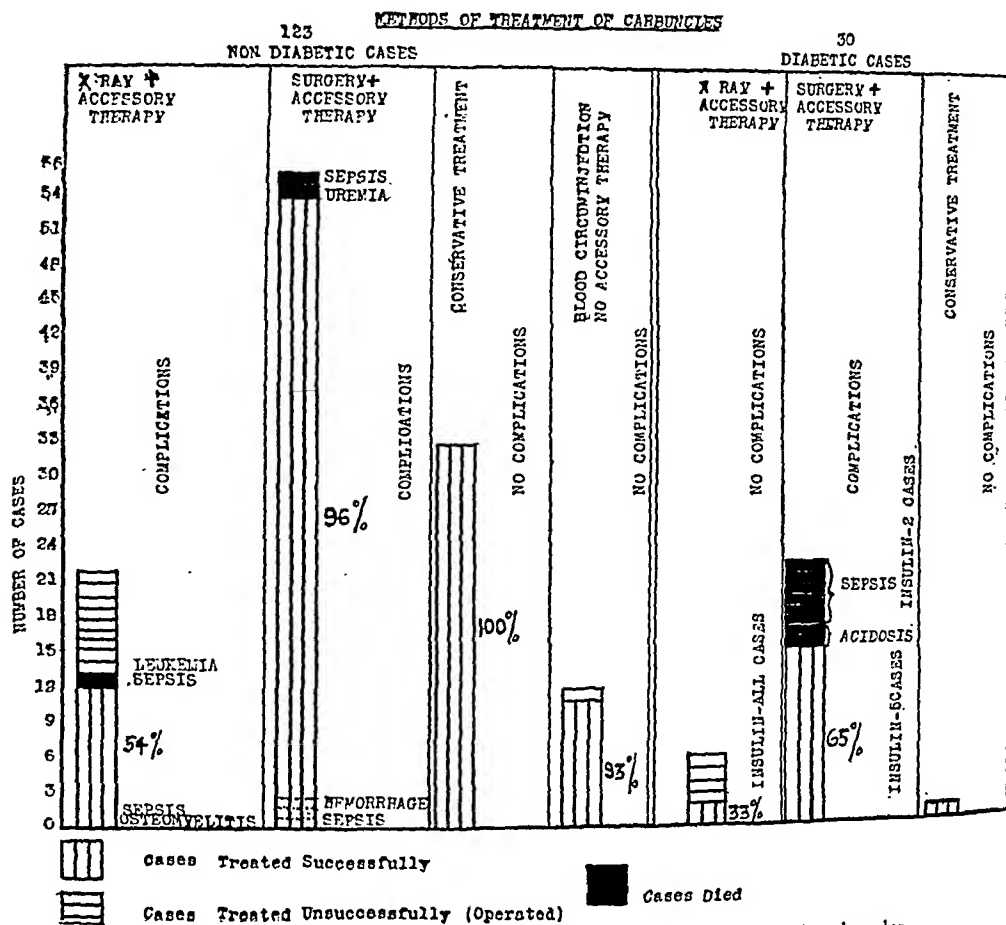


CHART I.—A comparison of four different methods of treatment of carbuncles.

To evaluate these methods is difficult, but any impressions or conclusions derived from recorded facts are worthy of consideration. With this in mind 153 cases of non-diabetic and diabetic carbuncles admitted to the Presbyterian Hospital in the last ten years were studied. Of these only 12 were treated in the out-patient department, and the remainder in the wards.\* Infections

\* There were many other smaller carbuncles treated in the out-patient department which are not included in this series.



## TREATMENT OF CARBUNCLES

of the face severe enough for hospitalization were classed as carbuncles. The four different methods of treatment were: X-ray, surgery, conservative therapy and autogenous blood circuminjection, the last having been discussed in a previous communication.<sup>1</sup>

A comparison of the four types of therapy used necessitates a consideration of the following variable factors, either in treatment or pathology:

1. Dissimilarity of carbuncles. A number of carbuncles of certain size and location, pathological involvement, virulence of organism, and resistance of individual may be treated by one method. It is obviously impossible to duplicate all these conditions for the purpose of comparison with another method of treatment.

2. Lack of definite scheme of tabulation of all the cases. For this reason many important facts and observations are lost which might otherwise prove valuable.

3. Accessory therapeutic measures. This is most important, for enthusiasm for any one particular type of therapy frequently makes one ignore the value of any incidental therapy. When such treatment is given it becomes difficult to tell what produced improvement or cure. Of the four methods of treatment under consideration, circuminjection of autogenous blood was the only one in which accessory therapy was not employed.

The efficacy of any treatment from the standpoint of patient and doctor alike embodies the following factors:

1. Relief from constitutional symptoms. Pain, loss of sleep and appetite, fever, chills, etc., cause the patient primarily to seek medical attention.

2. Avoidance of complications, especially bacterial.

3. The end-result. A minimal scar and good function of the involved area are very important. While a patient may disregard these at the time relief is sought, marked scarring, especially if visible, and loss of function bring complaint later.

4. Anæsthesia. Many dread a general anæsthetic, although direct deleterious effects of a brief anæsthesia are practically negligible, except in those in whom it is especially contra-indicated. Any good method of treatment which produces results without an anæsthetic is to be strongly considered.

5. The time element. This includes the time of hospitalization and the time for complete epithelization and return to duty.

So far as the applicability of a method for the doctor himself is concerned, the following must be considered:

1. The amount of skill required.

2. The practicability for all practitioners with limited facilities.

3. The practicability in large hospitals where every facility is available.

A study of Chart I and Table I will give a general idea of the efficacy of the various types of treatment after substitution of the various factors in the equations shown on page 706.

It is only fair to state that the cases receiving conservative treatment alone were not quite as severe as those receiving X-ray plus accessory

TABLE I.

Non-Diabetic							
Accessory Therapy <sup>3</sup>	X-ray <sup>1</sup> —22 cases	Surgery <sup>2</sup> —56 cases	Conservative—33 cases	Blood circuminjection—12 cases	Diabetic		
					X-ray—6 cases	Surgery—23 cases	
Location...	<i>Successful</i> Back of neck, 5 Scapular region, 1 Interscapular region, 1 Upper and lower lip, 1 Nasal region, 1 Upper lip, 1 Lower lip, 1 Sacral region, 1  <i>Unsuccessful—operated</i> Back of neck, 9  <i>Died</i> Upper lip, 1	<i>Successful</i> Back of neck, 27 Upper lip, 7 Lower lip, 7 Sacral region, 3 Occipital region, 2 Scapular region, 2 Buttock, 1 Post femoral region, 1 Zygomatic region, 1 Volar forearm region, 1 Nasal region, 1 Chin, 1 <i>Died</i> Trochanteric, 1 Lumbar, 1	<i>Successful</i> Upper lip, 17 Buccal region, 2 Lower lip, 8 Back neck, 3 Chin, 2 Nasal region, 1	<i>Successful</i> Back of neck, 10 Scapular region, 1  <i>Unsuccessful</i> Back of neck, 1	<i>Successful</i> Back neck, 2  <i>Unsuccessful</i> Back neck, 3 Interscapular region, 1	<i>Successful</i> Back neck, 10 Interscapular, 2 Chin, 1 Sacral, 1 Nasal, 1  <i>Died</i> Back neck, 4 Suprascapular, 1 Interscapular, 1 Temporal, 1 Lumbar, 1	Conservative—I case  Upper lip.
	Poultices. Carbolization. Narcotics. Boric compresses. Dakin's. "Thermolite." Ice compresses. Antiseptics	Poultices. Dakins. Narcotics. Wet dressings. Antiseptics. Ichthyol. X-ray. Carbolization. Blood circuminjection	The treatment itself equals accessory therapy and consisted in poultices, carbolization, narcotics, cold compresses, Dakin compresses, ichthyol, "thermolite," ice bag, antiseptics	None. The cases were selected by a committee as spreading carbuncles and only a dry dressing was used	Insulin, (all cases). Poultices. Dakin's. Narcotics. "Thermolite." Ichthyol. Caustic. Autogenous vaccine	Insulin, ( $\frac{1}{3}$ of cases). Poultices. Narcotics. Dakin's. Antiseptics. Transfusion	Treated with ichthyol and boric acid.
	1. 21 days after X-ray. Tissues involved to ligamentum nuchae 2. 16 days after X-ray. Pus under 1 flap.	1 case required 3 operations. 3 cases required 2 operations. Extension found			1. 13 days after X-ray 2. 11 days after X-ray	2 cases required 2 operations 1 case required 3 operations	

# TREATMENT OF CARBUNCLES

Findings at operation in unsuccessful cases	3. 14 days after X-ray. Extensive necrosis.	4. 12 days after X-ray. Extensive necrosis.	5. 10 days after X-ray. Ligaments of spine involved—area from ext. occipital protuberance to VI cervical vertebra and 4 cm. to each side of midline.	6. 3 and 8 days after X-ray. Extensive necrosis.	7. 7 days after X-ray. Extensive necrosis.	8. 5 days after X-ray. Muscle involved.	9. 3 days after X-ray. Extensive necrosis.	3. 4 days after X-ray.	4. 3 days after X-ray. All had extensive deep necrosis
Relief pain and constitutional symptoms	±	+++	++	+++	±	+++	±	±	±
Complications and death	+	±	-	±	-	±	-	±	±
Time element	+++	++	+	±	±	±	±	±	±
End result, scar function	++	+++	+	±	±	±	±	±	±

1. As a general rule the following technic was used:  $3\frac{1}{2}$  inch, spark gap, 3 mm. of aluminum as a filter, and a dosage of  $\frac{2}{3}$  to  $\frac{3}{4}$  of a skin unit (erythema dose). and three had excision.

2. By surgery is meant radical incision, crucial or multiple, with undermining of flaps and excision of slough in some cases. Fifty-one cases had this treatment therapy in those patients who had surgery is almost a negligible factor, for it is known that in control cases, where just a radical operation with drainage is done, the results are practically the same.

3. This means, as a general rule, a combination of accessory measures. The most frequent combination was poultice, carbolic acid, narcotics. The accessory results are practically the same.

4. The + signs express degree.

therapy. On the other hand, the accessory therapy as a whole was probably more intensive than the conservative treatment. The logical question which then arises is, "What produced the 54 per cent. cure in the first group; X-ray therapy, accessory therapy, or a combination of both?" In the diabetic and non-diabetic cases treated by this method, the extensive spread

Carbuncle + Surgery + Anæsthesia + Accessory therapeutic measures.....	} = ± Cure {	± Complications + Time element + End result
Carbuncle + X-ray - Anæsthesia + Accessory therapeutic measures.....		
Carbuncle + Blood circuminjection + Anæsthesia - Accessory therapeutic measures.....		
Carbuncle + Conservative treatment - Anæsthesia.....		

and tissue involvement will be noted in Table I in those cases considered unsuccessful and operated upon.

Summary.—The difficulty of evaluation of the various methods of treatment in this series must be apparent. Each case is a problem in itself and surgical judgment should be a guide in therapeutic preference. From the facts as noted, the following conclusions are presented for consideration:

1. In large carbuncles, diabetic and non-diabetic, the treatment of choice is radical surgery.

2. In small, superficial carbuncles and in some large carbuncles, including those of the face, X-ray therapy as an aid to conservative therapy (poultices, carbolization, etc.) has given good results. If, however, improvement does not occur in three or four days, other measures (surgery, circuminjection of autogenous blood) are indicated.

3. In diabetic carbuncles prompt establishment of free drainage is essential in order to prevent spread of infection. X-ray therapy without surgery is contraindicated.

4. Circuminjection of autogenous blood may be used in selected cases and it is a valuable adjunct in accessible spreading infections treated by any other method.

5. There has been no proof in the clinical cases analyzed in this series that X-ray therapy alone effected a cure. Reports in the literature seem to confirm this experience.

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## GAUCHER'S DISEASE\*

WITH REPORT OF TWO CASES IN BROTHERS

By HAROLD E. SANTEE, M.D.  
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SINCE Gaucher in 1882, originally described this disease which bears his name under the terminology of "*Epithelioma primitif de la rate, hypertrophie idiopathique de la rate sans leucémie*," numbers of cases have been reported until the present two cases represent about the fiftieth cases. These cases have been the source of much study due to their rarity and interest both clinical and pathological, and more recently to the surgical treatment by splenectomy and its effect on the constitutional condition. In 1926, Cushing and Stout in this country, and Ludwig Pick in Germany reported comprehensively on the cases to date. The latter lists thirty-nine cases of this interesting disease, the American writers by personal communications



FIG. 1.—Photograph showing skin bronzing and conjunctival thickening practically pathognomonic of Gaucher's disease.

and reports bring this number to forty-nine. Whether by careful perusal some of the latter may fall under Pick's secondary classification of "*Die lipoidzellige splenohepatomegalie (Tyhus Niemann)*" remains in question. I believe that I am conservative in stating from a review of these excellent articles that the disease is one of unknown origin which involves the reticulo-endothelial system pathologically in such a way that on section of specimens from this system we find usually in the order named spleen, liver, bone marrow and lymph-nodes packed with the typical Gaucher cells practically to the point of replacement late in the disease. Clinically we find progressive

\* Presented at New York Surgical Society, May 11, 1927.

enlargement of the spleen and liver, anemia and subicteric tinting of the skin. Bone changes may apparently precede spleen and liver enlargement in some cases, and the presence of wedge-shaped yellowish thickenings in the conjunctivæ are considered almost pathognomonic. That clinical recognition of the disease is much clearer than a conception of its pathogenesis soon becomes evident and leads one to conclude from an investigation of the theories as to pathogenesis that this disease is in familiar terminology neither "fish, flesh nor fowl" and may well fall into that class of diseases like Hodgkins, lympho-



FIG. 1a.—Photograph showing skin bronzing and conjunctival thickening practically Gaucher's disease.

sarcoma, primary endothelioma of lymph-nodes, etc., in which the true differentiation between neoplastic and inflammatory origin is extremely difficult. While the microscopic picture of the Gaucher cells is typical and the absence of lipoidal substance as well as the presence of the cerebrosid kersin apparently in the cell substance has been shown by Lieb and Epstein and confirmed by other workers, nevertheless these advances in knowledge of the disease have thrown no light on etiology nor offered any indication as to the treatment.

Splenectomy has been done in about thirty cases with an operative mortality about 20 per cent. Favorable results have been reported in sixteen cases, and it would seem from these reports that in this condition the average length of life is prolonged by splenectomy, even if the disease is not cured. Weight and strength have increased and anemia and hemorrhagic tendencies have decreased.

CASE I.—Man, C. S., age twenty-nine, single, born in this country, a sheet metal worker and steeple jack, was admitted to Bellevue, Second Surgical Division, on March 24, 1927. He first came under my observation in October, 1926, complaining of a "sprain of the left hip following a jump on a roof eighteen months before." This was followed gradually by increasing disability in the left hip particularly on active use. He had been hospitalized in Brooklyn and rest in bed, suspension and traction by weights, and a walking Thomas had all been tried without effect. In October, he showed on

## GAUCHER'S DISEASE

examination, anæmia, a liver three fingers below the costal margin, the spleen I did not feel, although looking for the cause of an anæmia, and a left hip which was painful on motion, somewhat tender on direct and indirect pressure, and restricted in both active and passive movement by muscle spasm. Loss of weight had been slight and no fever had been present. X-ray examination of the hip showed "slight irregularity and loss of detail lower half margin head of left femur which is tuberculous in appearance but without extensive bone destruction. Head of femur faintly mottled which may be due to slight rarefaction." The diagnosis seemed relatively clear and I favored the tuberculosis as against an afebrile pyogenic osteoarthritis. Hygienic treatment, arsenic and iron, and variations in splints were used until March, 1927, when he was referred into Bellevue on account of increasing anæmia, a sense of discomfort in the left hypochondrium, and increasing bone pathology as evidenced by "rarefaction about the head of the left femur and about the pubic and ischial rami." A blood examination shortly before had shown a negative Wassermann; hæmoglobin, 60 per cent.; white blood-cells, 3800; polymorphonuclears, 60 per cent.

On examination at this time, the patient showed an anæmia with sub-icteric tint; a liver which came to the umbilicus; a spleen which could be followed along its anterior border to the pelvis, smooth and hard; peculiar wedge-shaped thickenings of his conjunctivæ rather dark yellowish in color, and a left hip as has been described. The blood examination on March 27, showed white blood-cells, 2700; polymorphonuclears, 57 per cent.; lymphocytes, 43 per cent.; red blood-cells, 2,700,000; hæmoglobin, 48 per cent.; no nucleated red cells. The urine was negative for bile and Bence Jones albumin. A gastric analysis showed free HCl to be absent, total 10, no lactic acid. Gastro-intestinal study by X-ray showed a stomach displaced to the right but no intrinsic pathology. Blood chemistry was normal.

After consultation as to the wisdom of splenectomy in Gaucher's disease, the operation was decided upon. On April 4, the patient (Group 1, Jansky) was transfused with 600 c.c. of blood. At this time his icteric index was 19, and a Vanden Berg test was negative both direct and indirect. April 5, splenectomy was performed through a long left rectus incision. The liver was enlarged to the umbilicus, smooth, hard, faintly marked by yellowish lobular markings. A small wedge was excised for examination. The spleen was tremendous, extending from the dome of a pushed up diaphragm to the pelvis and filling the left side of the abdomen. No adhesions or perisplenitis were present, however, and the difficulties of removal were due mainly to the size of the organ and its delivery into the wound. The pedicle was clamped and cut close to the



FIG. 2.—Nodular Gaucher spleen.

hilus. At this time considerable blood was lost from the spleen itself which does not appear in its weight. The whole organ was delivered onto the abdomen except the upper pole, and a clamp through the gastro-splenic omentum freed the organ entirely. With this clamp, a small bullonhole was made in the fundus of the stomach which was repaired with a triple layer of fine chromic catgut. After hæmostasis and review of the wound the abdomen was closed without drainage. A transfusion of 500 c.c. was given.

Following operation, temperature immediately rose to 106 degrees, reaching 107.3 on the second day and signs of pneumonia appeared at the base of the right lung.



FIG. 2a.—Microphotograph—high power of spleen. Note replacement with Gaucher cells.

This persisted for eight days with a temperature ranging from 103 to 104 degrees, then subsided by lysis in the following eight days. April 7, two days post-operative and at the height of a pneumonic infection, the white blood-cells were 4800; polymorphonuclears, 58 per cent.; hæmoglobin, 55 per cent.

April 9, definite jaundice appeared, and April 12, the icteric index was 72, subsiding to 32, April 14. At this time the Vanden Berg test showed direct—delayed positive, indirect—positive. Convalescence has been slow but progressive since the pneumonia. Wound healing has been slow and infection occurred in the upper wound. April 18 and again May 9, transfusions of 500 c.c. have been given.

The pathological description by Doctor Symmers follows: *Macroscopic examination:* "Specimen consists of an enlarged spleen, weighing

2610 gms. with the blood that escaped from the organ at the time of operation. The spleen measures  $29 \times 15 \times 9$  cm. Seen through the capsule, which is perfectly smooth throughout, it presents an irregularly nodular appearance and is brick-dust red in color. On section, the organ cuts readily and the substance of the spleen is found to be riddled with rounded or oval, fairly sharply circumscribed nodules which are distinctly elevated above the surface, many of them discrete, some of them so closely packed as to give the appearance of confluent bodies. These tumors, as far as the naked eye is concerned, vary in size from a few mm. to about 2 or  $2\frac{1}{2}$  cm., although in one place there is a tumor which measures  $3\frac{1}{2}$  cm. in diameter. Most of the smaller tumors are reddish in color; the larger ones, however, present scattered over their cut surface numerous whitish or yellowish streaks. The large tumor just referred to presents a central area, stellate in outline, firm in consistence, whitish or cream colored, which is obviously composed of fibrous tissue. The rest of this large nodule presents the same naked eye appearance as those already



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referred to. The substance of the spleen between the nodules is rather leathery in consistence and scattered through it are myriads of pinpoint sized or slightly larger, whitish or faintly cream colored, glistening specks. In addition, the substance of the spleen presents equal numbers of rounded, sharply circumscribed, slightly elevated, glistening, faintly reddish bodies. Many of the latter, however, on being viewed through a magnifying glass, present a central whitish or cream colored glistening area with a reddish halo, the whitish areas being not unlike those without any evidence of a halo of red at the periphery.

Local application of iodine is negative, except for the fact that the peculiar color it lends to the spleen tends to accentuate the elevated condition of the small whitish or reddish or white bodies found scattered so richly through the substance of the spleen. The splenic substance between those bodies and between the tumor nodules, viewed through a magnifying glass, appears to be swollen, with a pinkish background and a distinct whitish or cream colored tint to it. The larger tumors shell out rather easily.

### *Microscopic examination*

shows the typical histology of Gaucher's Disease; that is to say, the splenic substance shows innumerable focal and streak-like collections of very large rounded cells with smooth, hyaline, faintly pinkish staining cytoplasm and a small nucleus, and an occasional giant cell with multiple individual or lobulated nuclei and the same sort of cytoplasm. Here and there are massively dilated blood sinuses, many of them completely or almost completely filled by cells of the sort just described. The follicles are still present, but most of them are atrophied. Many of them are surrounded by a definite halo of red blood corpuscles.

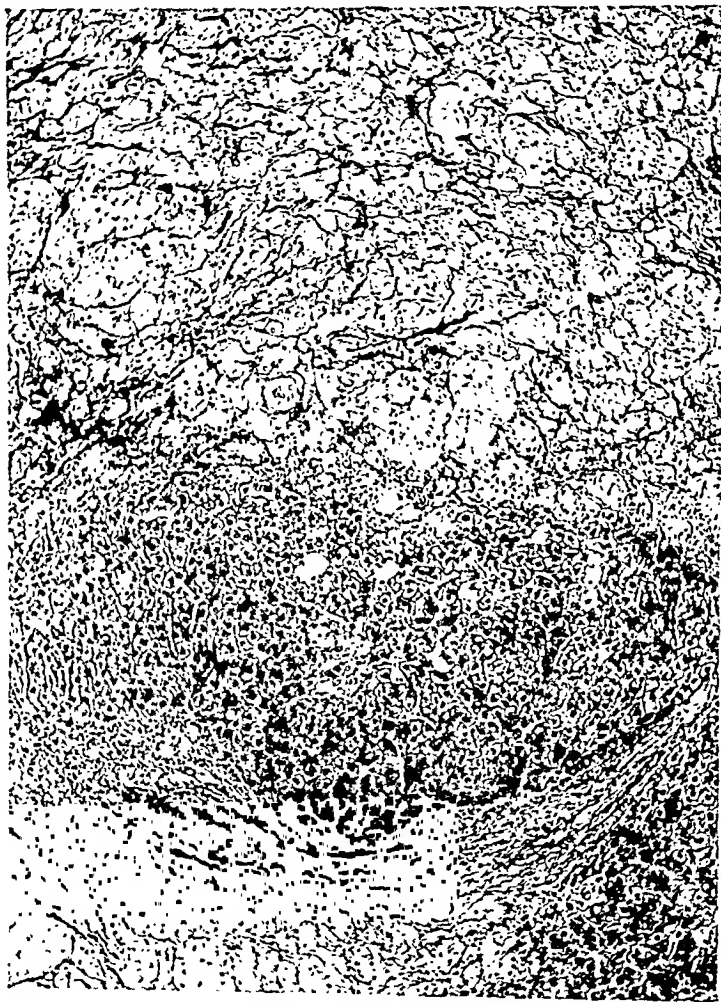


FIG. 3.—Microphotograph—high power—of liver, from small wedge incised from anterior surface near inferior margin. Note replacement with Gaucher cells.

In connection with the histology, it is interesting to note that, although numbers of splenic blood sinuses were choked with the large cells which characterize the histology of Gaucher's disease, careful search of the blood during life failed to reveal them in the peripheral circulation. Also, it is to be noted that in Gaucher's disease the lymph follicles are always eventually squeezed out of existence by the characteristic large round cells. In the present case, many of the follicles remain, although atrophic. This finding

would appear to indicate, it seems to me, that the disease is not of very long standing,

Finally, it is to be noted, that, of the forty cases of Gaucher's disease to be found in the literature, the spleen in every one of them was described as perfectly smooth. The present case, as far as I can learn, is the only known example of a nodular spleen occurring in Gaucher's disease.

Microscopic examination of small portion of the liver removed at the time of operation shows the presence of extensive infiltration of cells of

precisely the same sort as those described in the spleen, the infiltration taking place to such an extent as almost completely to replace the liver tissue."

Since the above pathological report I find that Ludwig Pick in 1926 reported one similar nodular spleen although the nodules were few in number and seemed more fibrotic in pathology than in the above spleen.

CASE II.—M. S., age thirty-one, married, a stenographer, born in this country, is a brother of

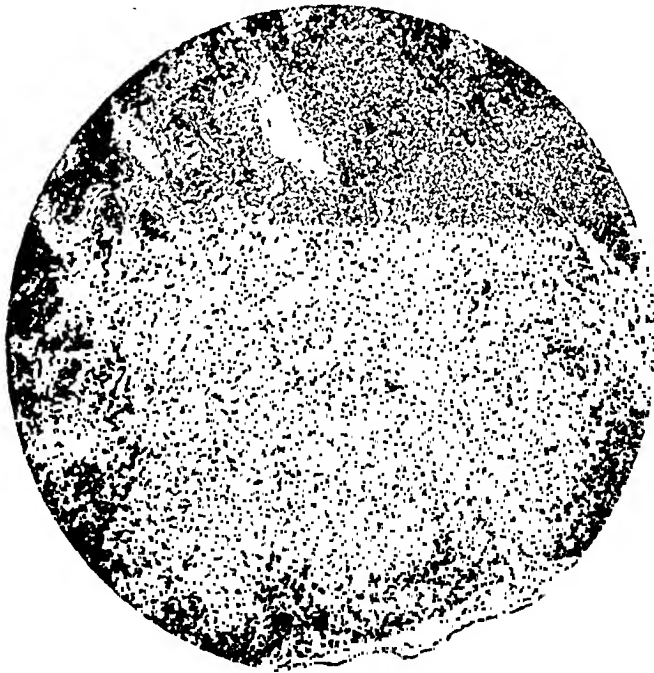


FIG. 4.—Microphotograph—low power—of lymph-node at hilus of spleen.

case number one. In tracing the family history from number one, we found that in a family of seven children with parents living, only this one brother was having any symptoms for which a physician was being consulted and that this brother was under observation for a "big liver". His history apparently dates back to 1917 when he was with the Mexican border troops. Several attacks of epistaxis and bleeding from the mouth brought him under observation at this time. He thinks a diagnosis of "malaria" (spleen?) was made. In hospital later, an enlarged liver was made out and periodically since that time he has been under observation for this liver. The hemorrhagic signs ceased but for the past three years, this patient has noticed a gradually increasing anemia with shortness of breath and asthenia, some "indigestion" and a constant feeling of pain and discomfort in the right lower chest and upper abdomen. Tonics and rest periodically have ameliorated the subjective symptoms but to the patient himself, they are gradually increasing. At no time have bone and joint pains been present.

Physical examination shows a pale anæmic man of slight build with conjunctival thickening as described by Brill. No icteric tint is present. Abdominal examination shows a liver that percusses dull from the fourth space above to the level of the umbilicus below where its firm sharp inferior margin may be easily felt passing from here across the mid-epigastrium. The spleen may be felt on deep inspiration at a

## GAUCHER'S DISEASE

similar level but is in no way comparable to his brother's in size. The blood picture shows hæmoglobin, 60 per cent.; white blood-cells, 5200; polymorphonuclears, 58 per cent. While the above picture on a single examination is not absolutely conclusive, I think you will agree with me in the diagnosis of Gaucher's disease in this case. After watching his brother, this patient rather desires splenectomy, but thus far I have not felt justified in advising it.

### COMMENT

The above two cases have been a cause of considerable thoughtful consideration on my part. Here apparently we have a disease of the reticulo-endothelial system varying quite markedly in its manifestations—one brother marked by chronicity (ten years), increasing anemia, and symptoms referable mostly to his liver. The other brother is marked by less chronicity (two years), obvious bone changes, and pain and discomfort referable mainly to the spleen, although liver is markedly enlarged. Reasoning by analogy, can splenectomy be justified in the second case on the grounds of relief to the damaged liver as in splenectomy in cirrhosis; as possible relief in a

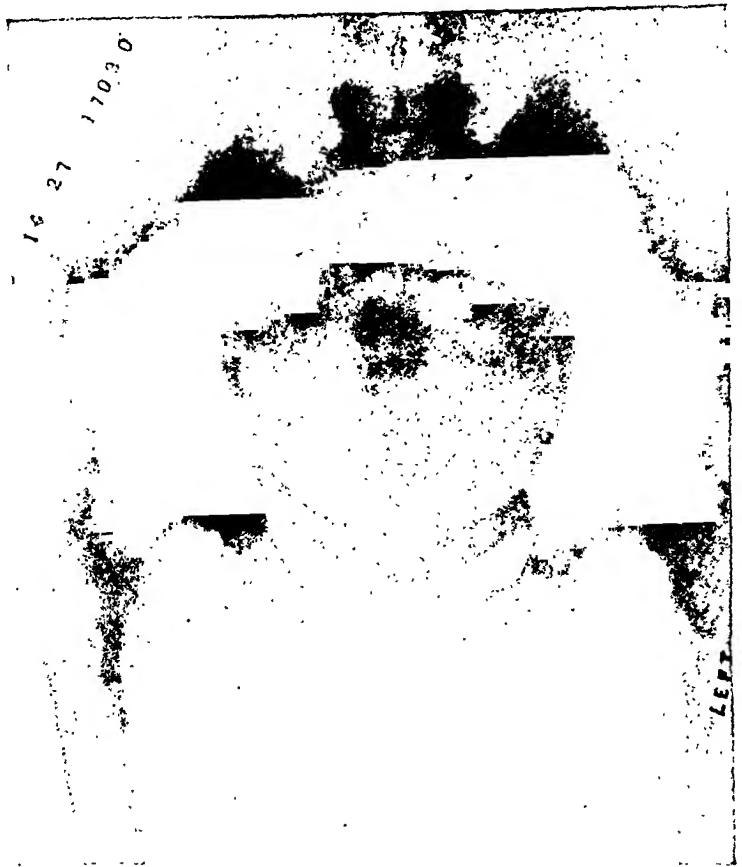


FIG. 5.—X-ray—note rarefaction lower part of head of left femur and in pubic and ischial rami.

marked secondary anemia; or as a mechanical removal of a heavy painful pressure producing organ? Certainly no one expects to cure a diffuse disease of the character of Gaucher's by removal of a single involved element. Relief of major symptoms, however, seems indicated even if it involves a very major operation and with the possibility of indirect beneficial results such as relief to a damaged liver and some benefit to the anemia, splenectomy seems to be justified although too few such cases have been recorded to warrant definite conclusions. Variations in the type and course of the disease as shown in the above two cases may be the determining factor in advising for or against operation in any particular case. And the same variations in type and course of the disease must be taken into consideration in evaluating the results of splenectomy.

HAROLD E. SANTEE

*Note September 21, 1927.*—Case number one was seen on September 9, 1927. His change through the summer has been remarkable. He looks well and has gained 20 pounds. His hæmoglobin is 70 per cent.; red blood-cells, 3,460,000; white blood-cells, 8400; and his differential shows polymorphonuclears, 36 per cent.; transitionals, 7 per cent.; lymphocytes, 49 per cent.; basophiles, 1 per cent.; large mononuclears, 7 per cent. He is relieved of the indigestion and sense of weight in the left abdomen. His liver remains as described. His hip shows no apparent change.

# THE PHENOMENA OF EARLY STAGES IN BONE REPAIR

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## INTRODUCTION

IN so large a collection of skeletal material as is to be found in the Hamann Museum of Western Reserve University, there are naturally many specimens illustrating the early stages of regeneration of bone after fracture. It has been our task to examine this material in detail for the observation on a large scale of the phenomena of bone repair. We have asked ourselves the following questions: What are the essential principles common to bone repair in different sites? Do all parts of the fractured surfaces and their immediately adjoining bone take part equally in the repair? What is the time relationship of the occurrence of the several phenomena of bone repair? Does the time relationship vary with the site or with the mammal? What modifications in the structure of repair are entailed by the type of fracture? What evidence is there of the site of origin of the definitive callus?

We are well aware that final answers to many of these questions can only be obtained by undertaking a research upon fractures artificially performed in the laboratory on living animals and by the preparation of specimens from human beings of known clinical history. The accumulation of data of the latter type is an exceedingly slow process. Our evidence here given is the result of fifteen years' patient collection. In by far the greater majority of cases there is to be obtained no history of the fracture from the records of the body as patients who reach hospital after fracture very rarely die. We had hoped that our hospital records would at least give us information regarding fracture of ribs followed by pneumonia and death, but we were disappointed. Those who die soon after fracture nearly always end their existence in Cleveland in doss-houses as human derelicts from pneumonia or delirium tremens.

Experimental work we have felt can be undertaken most profitably after and not before a searching inquiry into the evidence available in just such a survey as we propose to report.

Our work therefore is not to be taken as supplanting but as preparing the way for an experimental study which can, after all, be undertaken only on animals.

The writing of this report is the joint work of both authors who also agree upon the conclusions drawn but in the presentation and consideration of these conclusions the senior author takes full responsibility.

The setting forth of such evidence as we are about to present requires

first of all a searching histological study of bone repair. This study has recently been undertaken by Sullivan and his co-workers at Wisconsin<sup>1</sup> and a brief recital of the results obtained by these investigators forms a fitting introduction to the observations which we have been able to make. Under proper aseptic conditions Sullivan, Bast and Geist made sawcuts on

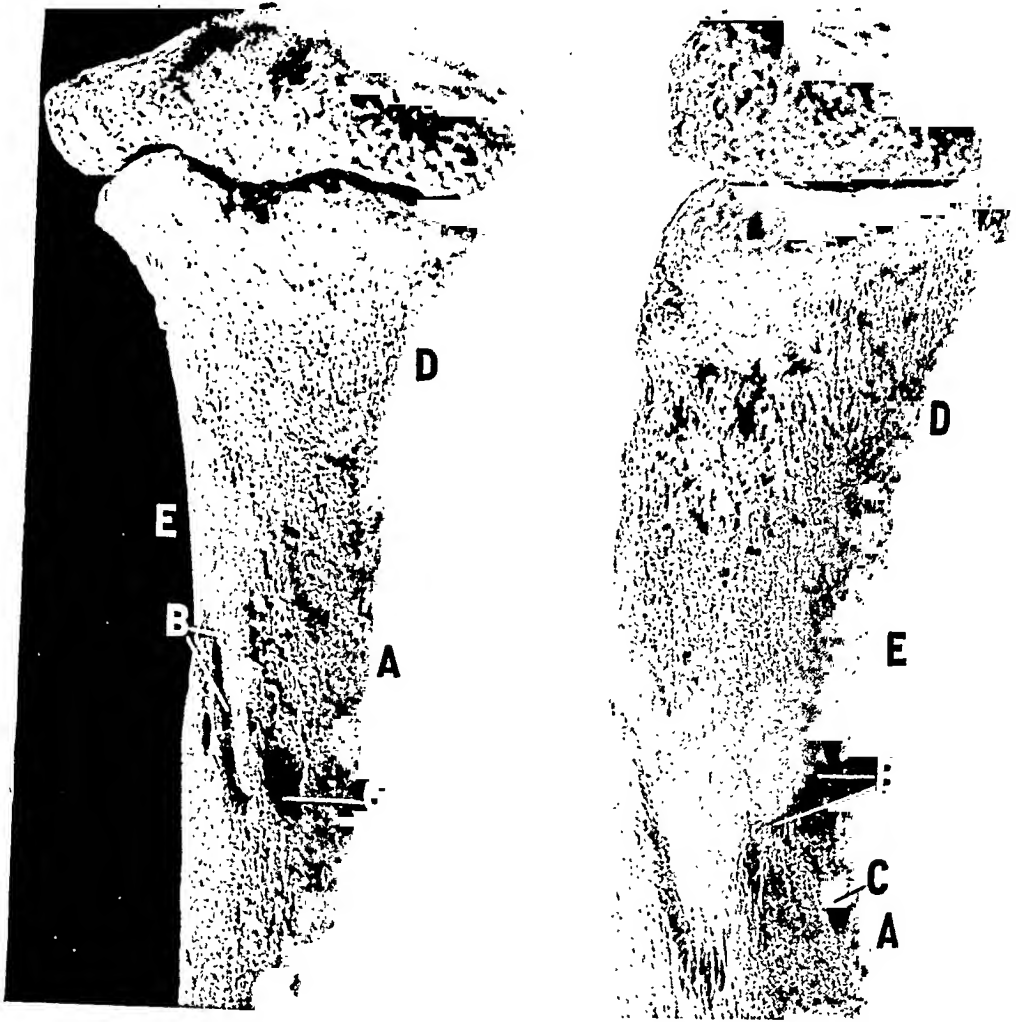


FIG. 1.—Left tibia, White male nine years, E. 16. Osteomyelitis three weeks' duration. Dorsal and lateral views. A. New bone of fourteen days' growth. B. Snail track ulceration of bone, the commencing exfoliation of the upper shaft. C. Nutrient foramen. D. Eroded upper shaft: bone of normal vitality. E. Clean bone of lowered vitality.

the upper tibiae of rabbits of unrecorded age and submitted the bones to histological examination on successive days.

The first day sections show clotted blood filling the cut with giant cells about the bone splinters necessarily produced by the sawing. The external osteogenic periosteum or cambium layer on each side of the cut is thickened by proliferation of its cells. The fibrous periosteum is œdematous. There is no endosteal change apparent.

On the second day masses of fibroblasts begin to organize the clot. The

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cambium is thickened on each side of the cut for a distance of one-eighth to one-quarter of the bone circumference. Proliferative changes commence in the endosteum.

On the fourth day new bone is present as dentations under the cambium and as long slender coalescing spicules extending into the marrow cavity.

On the fifth day cartilage surrounded by fibroblasts appears external to the cambium. Absorption of cortical bone begins beneath the external callus which itself appears more cancellous than hitherto.

On the sixth day internal callus completely bridges the cut and extends into it.

On the seventh day the external callus is extending into the now more advanced erosions of the cortical bone.

On the eighth day this union of external callus with the eroded cortical bone becomes more intimate and the internal callus shows signs of dissolution.

On the ninth day the external callus has also entered the cut and many osteoclasts are visible in both the external and internal callus.

On the tenth day external and internal callus have joined within the cut.

On the twelfth day the definitive callus has become cancellous, the external and internal callus are reduced in amount and there is more advanced absorption visible of the old bone on the face of the cut.

On the fifteenth day new bone completely fills the cut. There is transformation of the new bone by a process which does not involve the necessary presence of osteoclasts, and embryonic fibroblasts lie over the external callus parallel with the bone surface, indicating the direction of future periosteal fibres.

On the sixteenth day erosion is still marked in the old bone faces and



FIG. 2.—Right tibia and fibula chronic osteomyelitis, E. 85. Sequestrum formation. A. Sequestrum delimited by snail track ulceration of bone. B. Site where sequestrum merges with living but unhealthy bone. C. Active but unhealthy bone.

the external callus is much reduced. A line of osteoclasts is observable under the cambium.

On the seventeenth and eighteenth days this excavation of old bone continues and the erosions are rapidly filling with new bone. The new bone is taking the form of Haversian systems.

On the twenty-first day the external callus is entirely removed and even the bone plate in the cut is reduced in thickness.

On the twenty-fourth day the internal callus has almost disappeared.

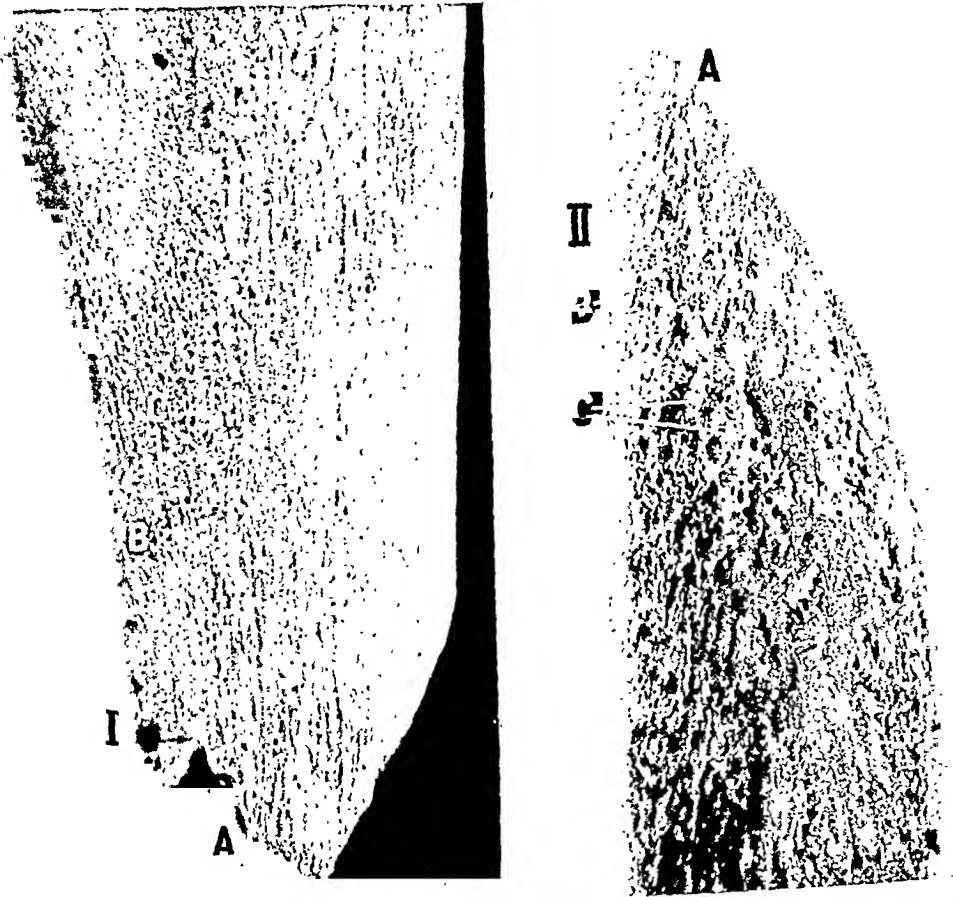


FIG. 3.—Right femur, simple comminuted fracture ca. eleven days. No. 156, male, White, forty-five. *I*. Superficial aspect, upper fragment. *II*. Medullary surface, lower fragment. *A*. Erosion of fractured face. *B*. Vascular erosion. *C*. Early stage of new bone formation.

In this account we observe that the two processes going on side by side in a cut the faces of which are accurately co-adapted—a “fracture” in which there is no mobility of the fragments—are erosion of the cut faces and adjacent bone and proliferation of new bone as callus. There is but little transitional cartilage produced. The source of the definitive callus seems to be the external and internal callus which rapidly disappear after the definitive callus is formed. Callus begins to appear on the fourth day and erosion is obvious by the fifth.

Certain observations are relevant at this stage. First there is probably little if any difference in local mechanical damage to the bone between a



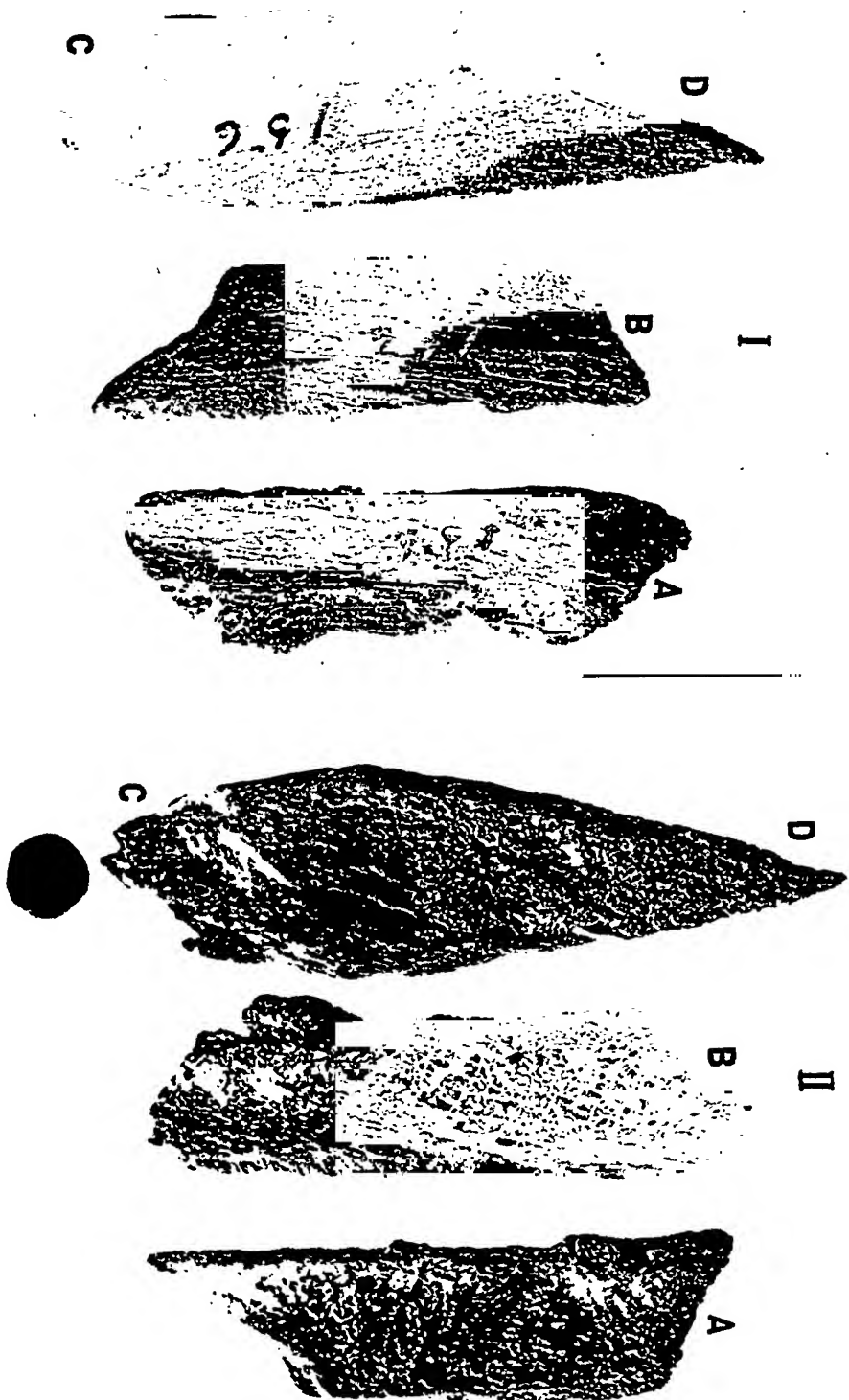


FIG. 4.—Same case as Fig. 3. Comminuted fragments. *I*, Superficial aspect. *II*, Medullary aspect. Pieces *A*, *B* show erosion of edges, vascular erosion, new bone formation. Piece *C*, *D* shows the same at end *D*, but at end *C* it is of diminished vitality, and, although not dead, shows none of these features.

sawcut and a fracture: in both the faces of solution in continuity have undergone a severe mechanical "bruising". Secondly, the early callus would not be visible on a radiogram and would certainly be removed in preparation of the specimen by ordinary maceration or cleaning. It is common experience that callus occurs in sufficient quantity to be apparent in a radiogram between the tenth and fourteenth days. It is also plain that erosion of the fractured faces cannot be apparent on the radiogram of the living bone since the bony texture is to a certain extent obscured by the soft tissues and the cedema.

*Erosion and New Bone Formation in Osteomyelitis.—*

It is instructive to observe the immediate consequences of acute osteomyelitis at this juncture.

A white boy, nine years old, suffered an acute attack of osteomyelitis in the upper left tibia which through bad surgery was treated by simple incision of periosteum and, fourteen days later, amputation for pus in the knee-joint. Since the area laid bare by the periosteal incision is well defined and there is new bone formation under the cambium beyond this area we can observe the amount of new bone laid down in fourteen days under the stimulus of acute inflammation. This amounts to 2 mm. in thickness. It is of relatively coarse texture and is channelled by vascular tracks. The very important relation of new bone to new vascularization is not touched upon in the researches of Sullivan, Bast and Geist.

FIG. 5.—Radiograms of No. 156. I, Upper fragment. II, Lower fragment. A, B, C, D comminuted fragments. Note the rarefaction of all areas adjacent to the fracture except C.

In the region of the upper diaphyso-epiphyseal plane the entire substance of the tibia is riddled with erosion and the marks of new vascularity. Delimiting the upper end of the ensheathing callus in the neighborhood of the periosteal incision is a trench-like snail track of erosion, plainly the beginning of separation of the upper tibia as a sequestrum. The bone above this snail track, unlike the upper extremity of the tibia, shows no such riddling with erosion. This is bone in a passive condition. One might surmise, by contrast, that its vascularity is reduced; it is certainly not increased. One could not say it is dead: it is passive certainly, reduced in vitality in all probability and marked for ultimate death. (Fig. 1.)

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The continuation of the process of separation of sequestrum is familiar in old standing osteomyelitis. (Fig. 2.) But it is not generally recognized that sequestrum separation may be permanently incomplete. In the tibia illustrated in our second figure there is one small area where no solution of continuity has taken place between the living though unhealthy bone and

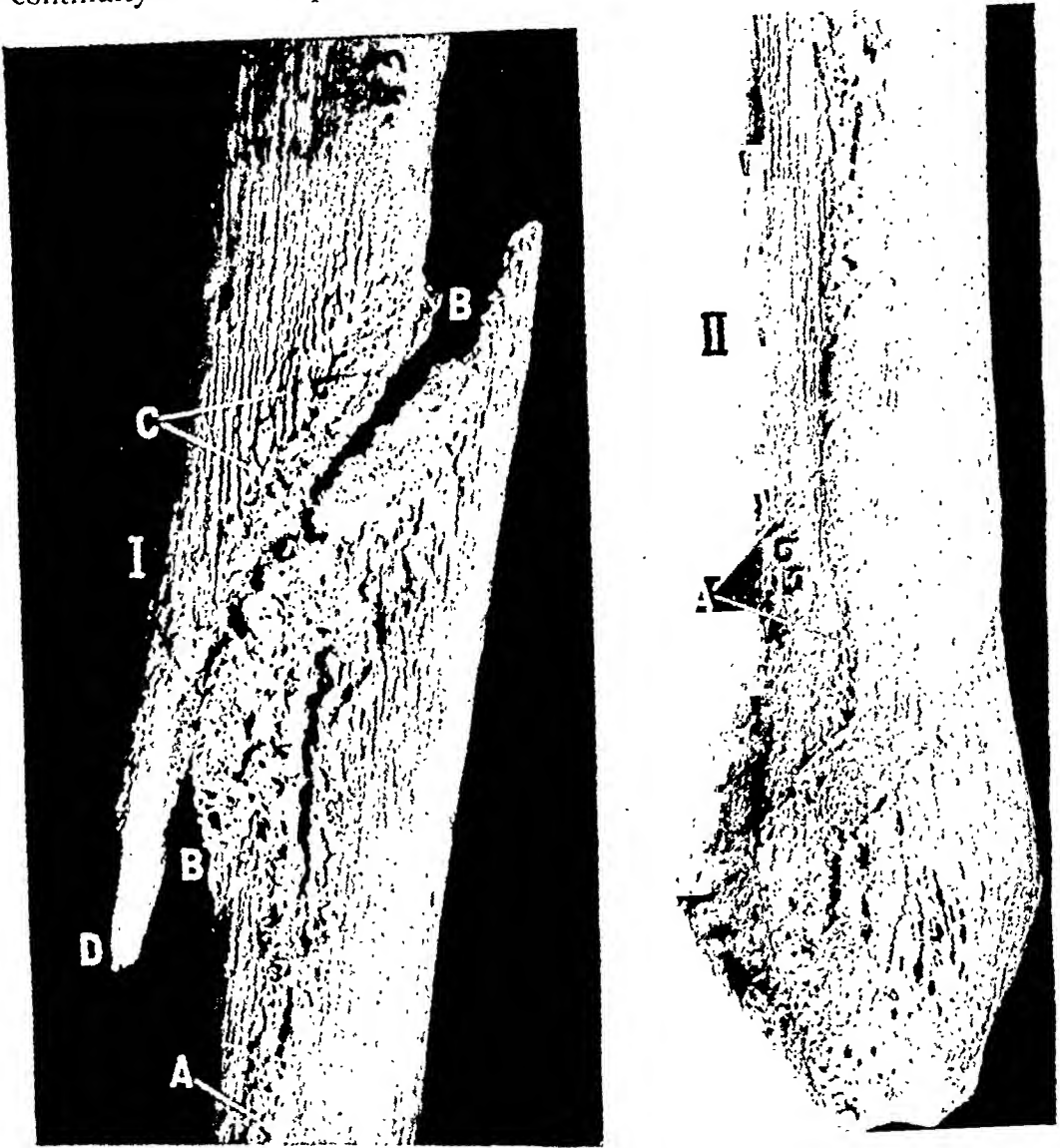


FIG. 6.—Simple oblique fracture with fissured extension left tibia. No. 388, Negro, thirty-eight; ca. seventeen days. *I*, Oblique fracture. *II*, Fissured fracture. *II*, Fits just below *I*. *A*, New bone filling and healing fissure. *B*, Lava-like callus of oblique fracture. *C*, Vascular tracks in new bone. *D*, Area of low vitality.

the devitalized piece. It is difficult to avoid the impression that devitalization is incomplete at this site.

*Vascularity and Erosion in Normal Active Growth of Bone.*—Quite recently the senior author has published an account of the gross features of normal growth of bone in the hard palate and elsewhere.<sup>2</sup> One of the cardinal principles emphasized in that study is the essential exaggerated vascularity of bone which is undergoing growth of active change, illustrated in the palate of the young Chimpanzee. The alveolar process is being much

altered through the change of dentition from milk to permanent and through the development and eruption of the permanent molars. The premaxillary and palate bones are stationary but considerable growth and change are going on in the palatal processes of the maxillæ.

We do not hold that vascularization is directly causal of bone growth or change; we merely insist that bone in such a state of activity requires more



FIG. 7.—Fractured faces of same oblique fracture. A. Ensheathing. B. Endosteal callus. C. Eroded fracture surface. D. Area of low vitality.

than ordinary nourishment and that enhanced vascularity is the method by which this increased nourishment is obtained. The degree of vascularity may be taken as an indication of the vigor of bone activity. With the vascularity there goes a certain amount of erosion. Channels open up in the old bone for lodgement of vessels, and among the eroded spaces new bone grows up.

The vascular granulations in which is to be found new bone are very readily seen and easily obtainable for further investigation in the healing cavity of a long bone.<sup>3</sup>

There is nothing new in this. The vascularization and erosion of active bone was well known to John Hunter. "Bones, according to Mr. Hunter's doctrine, grow by two processes going on at the same time, and assisting each other; the

arteries bring the supplies to the bone for its increase; the absorbents at the same time are employed in removing portions of the old bone, so as to give to the new the proper form.<sup>4</sup>" Eliminate the idea of the absorbents of lymphatics and we have a concise and accurate statement of what is going on in all bone which is active, whether from the stimulus of growth, repair or inflammation. We ought not to substitute the modern conception of osteoclasts for absorbents, for as frequently recorded (see Bast, Sullivan and Geist above and Macklin<sup>5</sup>) erosion is found in the comparative or even

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total absence of osteoclasts. It would be better, in the light of our present knowledge to say merely that bone is melting away like snow in the sunshine, leaving the discussion of cause out of the problem.

Hunter indeed performed one series of experiments showing conclusively that it is the active living bone which is eroded. "He cauterized portions of bone in the same way in different animals, so as to be able to examine the bones in the different stages of this -- process, and found that the earthy part of the living bone in contact with the dead portion was first absorbed; afterwards the animal mucilage itself, so as to form a groove between the two, which became deeper and deeper, till the dead bone was entirely detached, the dead portion itself having undergone no change.<sup>4</sup>"

Macklin has made a careful study of bone undergoing repair and attributes the erosion to a cell which he finds in large numbers, of varied origin and containing many granules which readily take trypan blue as a vital stain. One of the most striking results of Macklin's study is the demonstration of areas of damaged or devitalized bone by the same vital stain.<sup>5</sup>

There is a very good description by Phemister published some years ago in this Journal,<sup>6</sup> but the author had not the opportunity of consulting a previous detailed histological study of the phenomena of bone destruction and repair. With the majority of his findings, however, we are in complete accord.

It has been held that clot around a fracture organizes in four to five days,<sup>8, 9, 10</sup> that new bone formation can be found on the eighth<sup>10</sup> or tenth<sup>8, 9</sup> day, that fragments are bound together by the thirteenth day<sup>10</sup> and that bone resorption occurs along with repair.<sup>8</sup> These observations differ slightly in time from those of Sullivan,<sup>1</sup> the difference probably being due to the fact that they were made upon complete fractures.

In his war work the senior author noted that erosion on the face of fractures or edges of operative wounds in bones results in the formation of small

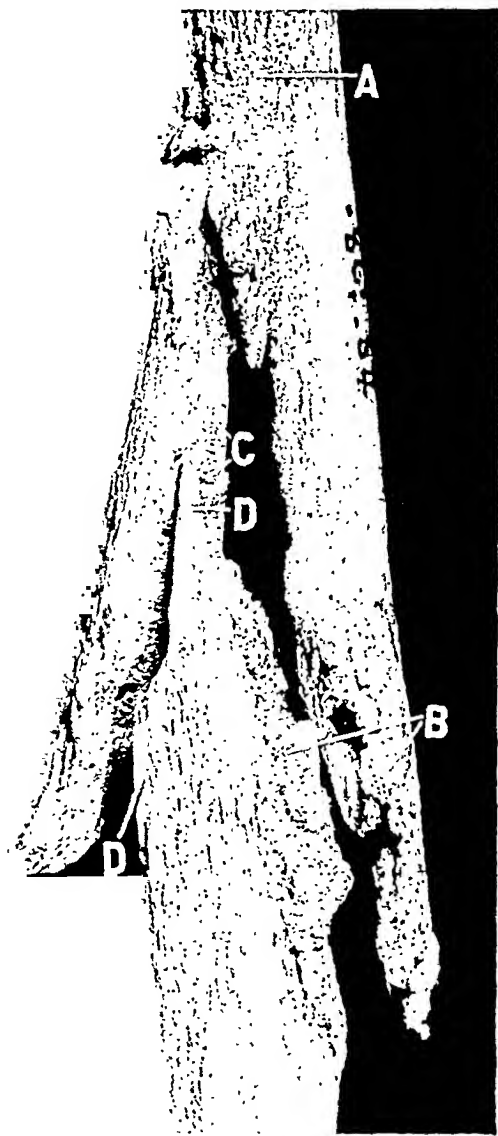


FIG. 8.—Simple comminuted fracture of upper left fibula from same case. A. Healed fracture. B. Ensheathing. C. Endosteal callus. D. Area of low vitality with callus cap into which it fits.

flake-like sequestra which can usually be found within three weeks of the traumatic injury but continue to exfoliate in increasing numbers for six weeks after the injury.<sup>3</sup>

These observations and references lay the foundation for a detailed study of representative specimens illustrating the early stages of bone repair.

*Repair in Long Bones.*—No. 156 is the skeleton of a white male, forty-five years of age. The body of this individual was received from the County Morgue and there is

therefore no clinical history. Death was due to lobar pneumonia. The fracture is obviously recent: by the actual findings discussed below it cannot be more than fourteen days old. Now there is every likelihood of the fracture being the predisposing cause of the pneumonia. Allowing therefore two days for onset of lung complication and nine days for it to reach its height, we are probably not far wrong in citing the case as illustrative of a human femur eleven days after injury.

Now we readily admit that this argument is based upon probabilities which indeed confirm each other but have not, even amassed together, the weight of certainty. And we admit also that it is a simple matter to produce fractures in animals and study the results at definite intervals; we regard this as the next stage, logically, of a scientific investigation of fractures. But we insist, first that this present research is a proper preliminary; secondly, that mammalian bones are not human bones and although details of repair may be perfectly consistent in order and date of appearance, the gross result need not necessarily be precisely the same in such different sized bones as those of dog and man, at precisely the same intervals after injury; and thirdly, that actual recent fractures in human bones are extremely difficult to obtain and that the specimens here recorded form as good a selection as medical science is likely to obtain. We have not slightest hesitation in presenting these bones for serious consideration.

FIG. 9.—Right lower tibia, recently healed fracture. No. 453, male Negro, fifty. Note erratic formation of new bone and large fenestration at bottom of which is a fragment of low vitality A.

The right femur shows a simple comminuted fracture in the middle of the shaft. The edges of the fragments no longer present the clean-cut crystalline appearance of a recent fracture: they are eroded and irregular. In the erosions appear tiny granular masses of new bone. There is as yet only the slightest icing of callus on either external or internal surface. But the fragments of the shaft, for a distance of 110 mm. from the fracture are eroded by large vascular grooves parallel with the long axis of the shaft. From these vascular grooves newly formed foramina perforate the cortical tissue. These are early signs of repair in a bone showing active reaction. Such

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external callus as there has been removed from the large fragments but endosteal callus which has already reached the stage of cancellous bone is clearly seen on the endosteal aspect (Fig. 3), a stage noted by Bast, Sullivan and Geist on the twelfth day.

In this specimen are three small comminuted fragments on which callus has collected on both surfaces and appears as new cancellous bone. (Fig. 4.) The edges are eroded and upon them also is definitive callus, but there is not yet any attempt at actual union of the fragments which are similar in their appearance to specimens of

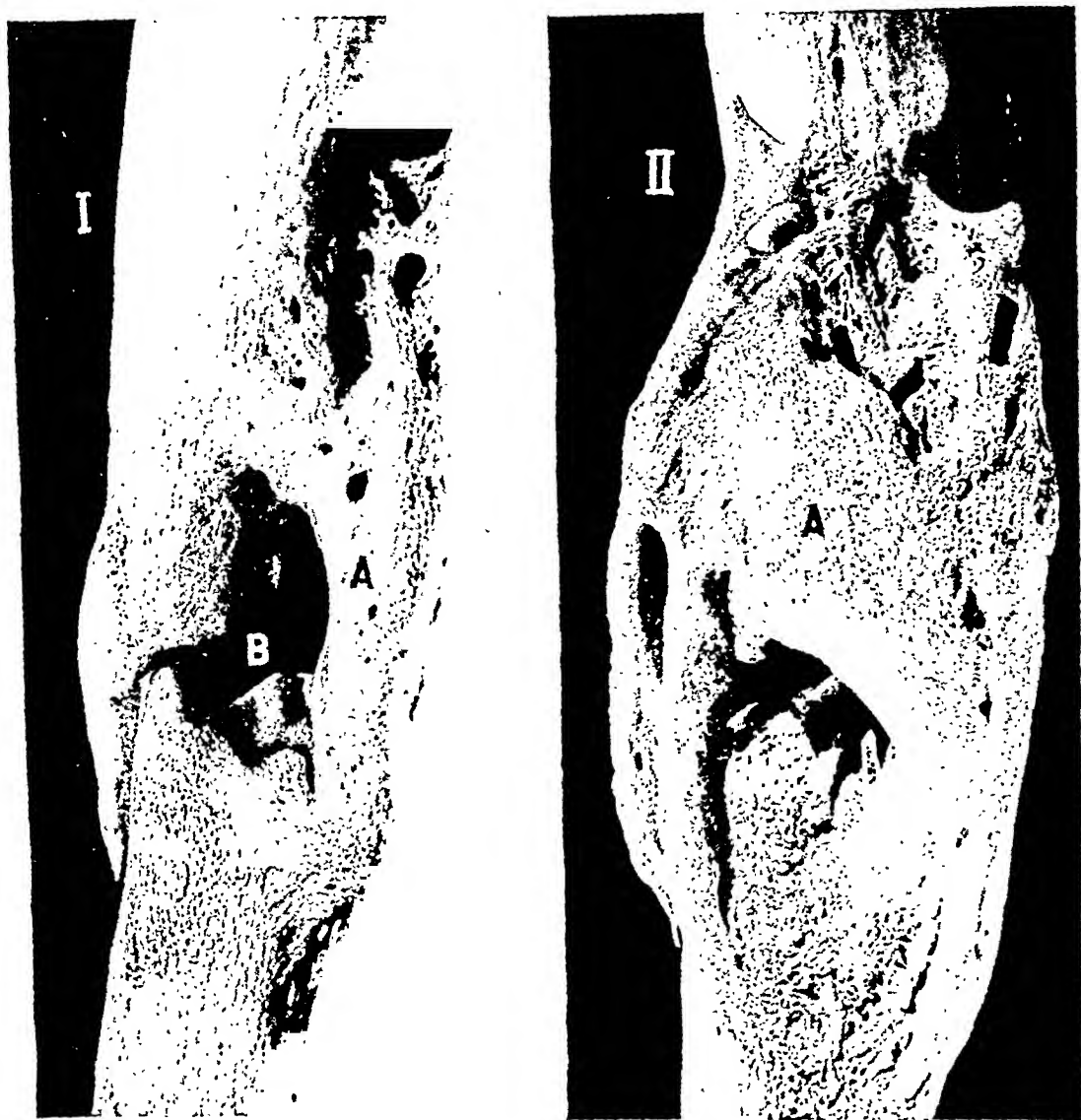


FIG. 10.—Old-standing simple comminuted fracture. Left femur. No. 1380, male, Negro, forty-six. I. Lateral. II. Dorsal aspects. Waxy surface indicates old healed condition with development of compact layer. A. Fragment which has retained vitality and entered into formation of new bone. B. Fragment of low vitality in its fenestration.

Bast, Sullivan and Geist between the tenth and twelfth days after injury. They found erosion under the external callus starting on the fifth day and much more pronounced on the seventh day. The amount present here indicates the passage of several days of activity.

The external surface of the lanceolate fragment C. D. is most instructive for one end alone is eroded. The other end shows neither vascular pits nor grooves: it is marked only by the regular impressions of the normal periosteal vessels and its edges are still crystalline. In the specimen the area is pallid compared with the rosy hue of other areas. This bone is not necessarily dead: it is passive, perhaps

of reduced vitality. We shall show other specimens in which a fragment in this condition becomes an integral part of the new structural bone albeit a passive part. Our first conclusion, however, is that, in a simple fracture, the several areas of fractured bone are not equally active in bringing about repair.

No. 388 is a negro male, thirty-eight years of age, who died of pulmonary tuberculosis and was received, like the last, from the County Morgue. The nature of the illness gives us no real clue to the time the patient lived after injury, but there are

certain indications in the specimen itself. An oblique simple fracture of the left tibia near its middle, is continued downward to the articular surface as a fissured fracture with a spiral upward and backward from the lower end. These accessory extensions of the fracture are filled with a new cancellous callus and the external callus is reduced or absorbed. Bast, Sullivan and Geist describe this phase on the fifteenth and sixteenth days. One would be quite justified in regarding the specimen as seventeen to twenty days after fracture and this fissured fracture is far more comparable with the sawcut of these investigators than the complete fractures which would have presented a practical problem had the patient lived.

Here again we find that the bone is not equally active in repair throughout. This is specially apparent in the illustration of the lower shaft. (Fig. 6.) This variable activity is characteristic of all our recent fractures. It must be understood, however, that inactive areas are not by

FIG. 11.—Ununited fracture lower shaft right humerus. No. 1460, male, White, sixty-one. Note weak reaction characteristic of this age. Erosion feeble. No real callus but some chronic inflammatory new growth.

any means necessarily dead; their vitality doubtless is diminished and they will die and form sequestra more easily than more active areas in appropriate circumstances.

The oblique fracture itself is not yet united (Fig. 6), but the vascular grooves and pits are present leading up to masses of lava-like external callus becoming cancellous. Callus has penetrated but not yet covered the fractured edges. (Fig. 7.) Indeed the edges of the upper fragment are still clean and crystalline. The difference between eroded and crystalline fractured surface is well seen in the over-riding apical ends of the fragments. (Fig. 6.) The lower fragment has a much more active surface than the upper.



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There is no need to assume delayed union in this fracture. Wherever a complete fracture is associated with an incomplete, greenstick or fissured fracture, the latter heals at an earlier date than the former.

Associated with this tibial fracture is a simple comminuted fracture of the upper third



FIG. 12.—Four types of rib fracture from Airedale bitch thirteen days after injury (B. 835). A. Buckling of left twelfth rib. B. Greenstick fracture of right thirteenth rib. C. Complete interlocked fracture of left seventh rib. D. Complete mobile fracture left ninth rib. For characteristics see text.

of the left fibula. In general the phase of repair of this bone is identical with that of the tibia, but some features are much better marked. The cancellous nature of endosteal callus is even more strikingly developed than the cancellous transformation of the massive lava-like tibial callus. Relative inactivity of some areas of the fragments is beautifully

demonstrated. (Fig. 8.) The partial fracture in the upper fragment is already healed. Most of the fractured edges are clothed with callus, but on the lower fragment are three areas totally inactive and appearing as more pallid glistening projections, each of which fits into its cap of cancellous new bone on another fragment. We think that quite probably, had the patient lived, these areas would not have died but would have become ensnared by and embedded in the new structural bone; they would, however, contribute to it nothing more than their bulk and strength, not life or power to initiate new growth, for of the former they had little and of the latter none at all.

No. 453 is a recently healed simple oblique comminuted fracture of the lower right tibia in a male negro, aged fifty years. Again there is no information giving a clue

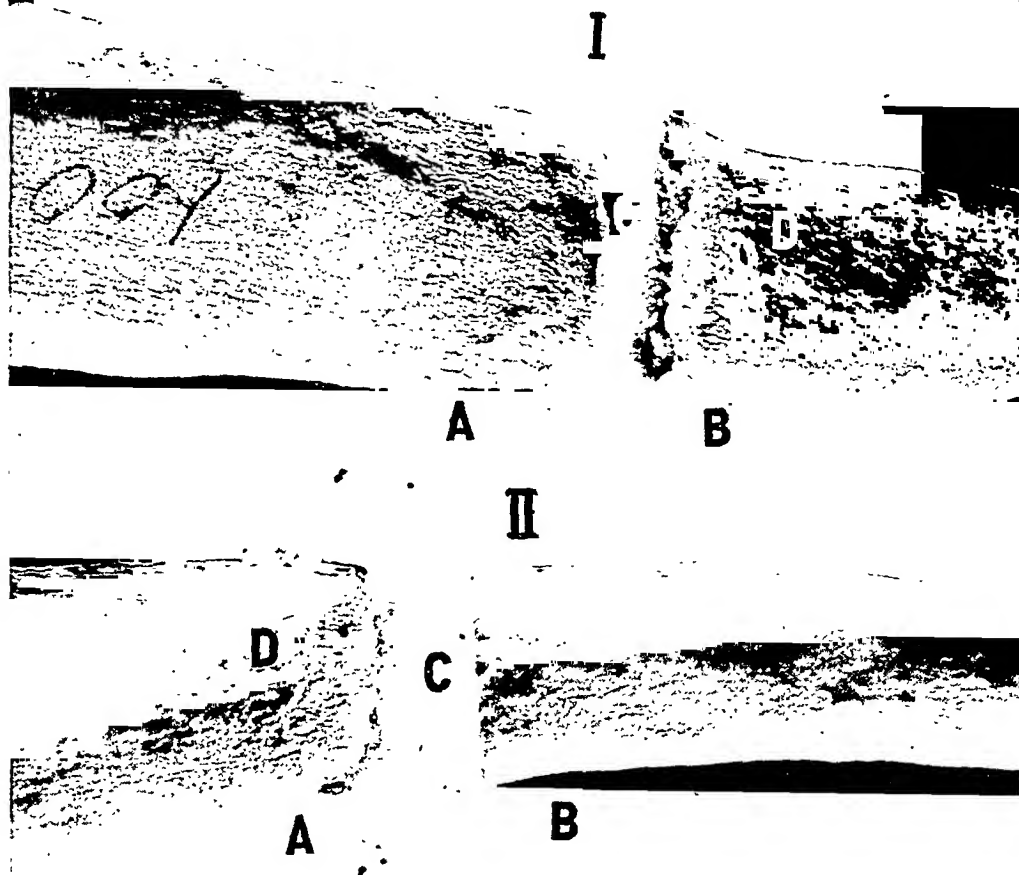


FIG. 13.—Right fifth rib: recent fracture. No. 1007, White, male, sixty-one. I. Deep. II. Superficial aspect of rib. A. Dorsal. B. Ventral segment of rib. C. Bare eburnated fragments of low vitality. D. Weak effort at vascular erosion and ensheathing callus.

to the elapse of time since the fracture, but the cancellous appearance of the callus indicates that healing had not been complete for many months. The erratic nature of the healing process is quite definite. (Fig. 9.) At the bottom of the largest hiatus is to be seen the smooth inactive end of one fragment of the shaft which nevertheless is embedded in and forms part of the rebuilt bone: it is not dead but passive.

No. 1380 is an old simple comminuted fracture of the left femur in its middle third from a negro male of forty-six years. The two main fragments are solidly united by fenestrated plates and bridges of new bone. There is no over-riding of fragments. The uniting callus has now taken on a waxy appearance in marked contrast to the cancellous texture of No. 453. This waxy surface texture is characteristic of long stationary callus. (Fig. 10.) Again the fenestrated character of the union is

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apparent, obviously due to inequalities in repair ability of the several areas. At the lower end of the large fenestration is a cuboidal piece of inactive but yet living bone, a comminuted fragment which has become incorporated in the new structural bone, much as a rock may lie in concrete. Again this piece is not dead; doubtless it had had years during which it might have become a sequestrum but it remained alive embedded as a non-coöperating mass in the newer bone.

A very different fate has befallen the similar comminuted fragment on the back of the shaft. This never had its vitality diminished; it took an active part in throwing out new bone and by its own activity has formed an essential part of the newer built structure.

No. 1460, the right humerus of a white male, aged sixty-one years, presents an ununited fracture of the lower shaft which was in very poor position. (Fig. 11.) The

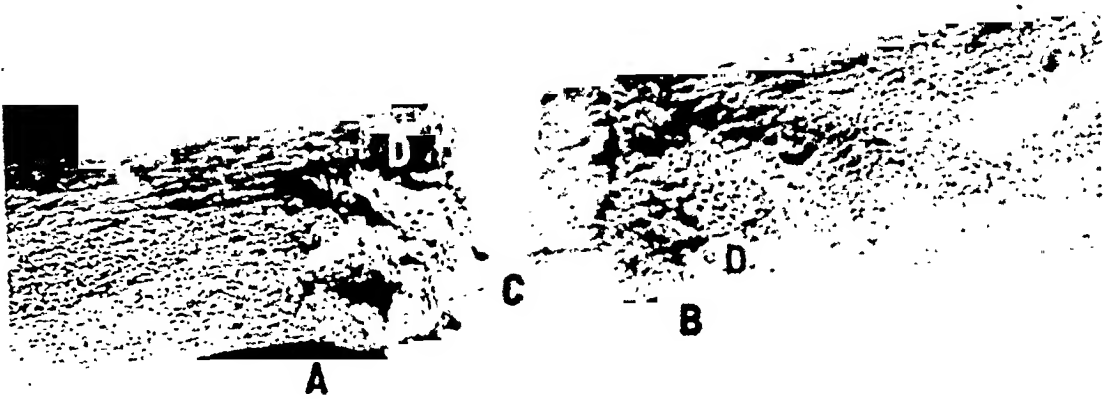


FIG. 14.—Right eighth rib: recent fracture. No. 1173, Negro, male, forty. A, Dorsal. B, Ventral segment of rib. C, Bare eburnated fragments of low vitality. D, Pronounced vascular erosion and ensheathing callus with vascular channels in new subperiosteal bone.

bone is instructive because, although there is erosion of the actual fractured edges, there is no real attempt at repair. There is no erosion, vascularization or pitting of the fragments, no throwing out of new bone as callus, but merely a feeble development of new bone of which the waxy surface bespeaks its age, the result of traumatic inflammation. It bears no evidence of the purposive character of callus.

Probably failure to develop the phenomena of repair is related to the patient's age. A marked change in texture takes place in the skeleton during the fifties, starting in ribs or vertebrae and progressing thence throughout all bones.

We cannot close this account of the early phenomena of repair in long bones without referring to one strikingly successful repair after the use of Lane's plates. No. 973 is a white male of twenty-eight years. The illustration shows the even and complete union of fragments of radius and ulna. The screws remain tightly embedded in bone substance.<sup>7</sup>

So far then we learn that the early characteristics of bone repair are erosion of the fragmented edges, erosion and vascularization of the fragments themselves and an irregularity about the appearance of these features, the fractured areas being of unequal vitality.

We have seen that callus develops on outer or subcambial surface, on inner

or endosteal surface and on the actual faces of the fracture, that this callus develops at the same time as erosion is occurring, that it is first lava-like, next cancellous and much later of a waxy surface texture.

Lastly, we have seen that immobile fractures, greenstick, fissured, or spiral incomplete fractures may unite vigorously and quickly in spite of their immobility, whereas mobile fractures always take longer to unite and may never unite at all, an unfortunate termination more liable to occur if there is deficiency of the substance which controls new bone development. When we rub



FIG. 15.—Recent comminuted fracture right parietal area. , Cercopithecus monkey. Cercopithecus sp. B. 1042. In this and the following figures note the unequal vitality of fractured faces; the erosion and vascularization concomitant with repair; the sprung coronal suture which shows no evidence of repair; commencing repair in fissure parallel to left coronal suture; and the vascularity indicative of repair in the left inferior spheno-temporal suture.

the ends of a fractured bone together the edges probably do not throw out new osteoblasts, although perhaps more callus is developed roundabout as the result of traumatic inflammation. For a more precise understanding of the effect of rubbing together the fractured surfaces we should consult the ensuing pages on ribs.

*Repair in Ribs.*—Four types of fracture are well illustrated by the ribs, two of incomplete solution of continuity, namely buckling and greenstick and two of complete break, namely of limited and of great mobility. All these types may be found after a single accident and we describe them from a pure-bred Airedale bitch eleven months old (B835), thirteen days after injury. (Fig. 12.)

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The simplest fracture is a mere buckling of the bone shown in the left twelfth rib 8 mm. from the costo-chondral junction. The acute angle of the bend is on the deep surface, but there is no break in the compact bone on either aspect. The superficial surface of the rib shows some increased vascularity with its accompanying and preceding erosion: the deep surface is still stained by hemorrhage and there is a small amount of external callus laid down in the angle of bent rib. Rather striking is the fact, confirmed in other specimens of our collection, that there is more callus formation at the lower edge of the rib near the intercostal artery than at the upper edge. It is true that this may be a coincidence of somewhat frequent but not necessary occurrence.



FIG. 16.—View of vertex of same skull. Note sprung condition of coronal suture with no evidence of repair. Other parts of the skull show considerable though erratic callus.

The right thirteenth rib illustrates well the features of a thirteen-day-old greenstick fracture near the middle of its length. There was a small break in the cortex on the superficial aspect and the fractured edges show no great attempt at repair. Apparently these are areas of impaired vitality for no erosion, vascularity or external callus characterizes the adjacent bone. Upper and lower rib margins, on the contrary, show a small amount of fine textured external callus, that on the lower margin being the greater in amount and extent. On its deep aspect the rib cortex presents the typical vascularity of repair and there is a good deal of fine textured external callus. One can hardly avoid the conclusion that fine texture of callus is associated with immobility.

The left seventh rib is completely fractured 50 mm. from its costo-chondral junction. Thirteen days give too little time for union but active repair is in process. The greatly eroded edges of the fragments are surrounded within and without by masses of callus, the entire cancellous tissue of the rib medulla being transformed. Neither this internal callus nor the external callus has yet united across the gap, but the projecting spicules of the eroded fragments have interlocked and inhibited movement at the fracture line. The steadiness of position of the fragments in this fracture must certainly be held responsible for the widespread and vigorous repair process, not because steadiness of

recent fractures, but it can be stated upon the evidence presented by our dog, B835, that thirteen days are a long enough period for solid repair of a crushing fracture of the vertebral body.

*Repair in the Skull.*—Recent fractures of the skull are extremely rare. If the individual does not die immediately he lives long enough to lose all trace of the recent phenomena. We do have one Cercopithecus monkey, B1042, which suffered an atrocious comminuted fracture of the vault and lingered



FIG. 19.—Right parieto-occipital area of skull No. 1212, White, male, age forty-five years. Note vascularity and erosion indicating commencing healing in fracture which runs through or close to site of united right lambdoid suture.

for some days, perhaps as much as three weeks. But there is no history and we do not even know whether the fracture is simple or compound.

The recent healing fracture involves the entire right parietal bone, forces open the entire coronal and the right temporo-sphenoidal sutures, and has also a fissure running through the left parietal just behind the coronal suture. Typical repair with erosion, vascularization and new bone is apparent throughout the right parietal and in the fissured fracture of the left parietal but nowhere is to be seen in the sprung coronal suture. Curiously enough the sprung temporo-sphenoidal suture, especially its lower part, does show the vascular erosions typical of repair. Why there should be this peculiarity in location of repair, the singling out of one suture and the rejection of the other, is too large a problem for this paper and of no clinical significance. We shall therefore content ourselves with pointing out the facts and leaving the evidence for later development. Even throughout the right parietal bone repair is weak and quite as unequal in activity in different areas as in the other bones of the body. There is a generalized

## EARLY STAGES OF BONE REPAIR

subperiosteal deposit of bone and a similar but less pronounced deposit on the dural aspect. (Figs. 15, 16, 17 and 18.)

The only quite recent fracture in a human skull at our disposal is shown in Fig. 19. This is the right parieto-occipital area of No. 1212, male, white, forty-five years, a patient in the insane asylum who died a few days after fracturing his skull. We have not succeeded in getting any clinical history. The figure shows the right lambdoid suture closed so far as it ever would have closed in this individual: it is a condition of the lambdoid typical of the patient's age. Vascular erosion is well marked all along the fracture but there are only scattered vestiges of callus.

Sufficient evidence is here given to show that there is no essential difference in principle of bone repair in the skull vault from other parts of the skeleton. Such modifications as exist are called forth by local conditions.

### GENERAL SUMMARY

The principles of bone repair are few and simple; their application very varied. The fragments show erosion and vascularity. Part of the erosion is undoubtedly removal of bone devitalized in the actual process of fracture; part is the channelling of old bone adjacent to the fracture by the burrowing and multiplication of blood-vessels which are bringing the necessary pabulum for nourishment of the repair cells. On the eroded areas of fractured face and adjacent surfaces, subperiosteal and endosteal or cancellous, there appears a callus of varying texture, finely granular in immobilized fragments, lava-like in those which are movable. Through successive stages this callus is transformed into a cancellous mass and later into tissue with Haversian systems. Ensheathing and endosteal callus become reduced or eliminated and the former so modified that a cortical waxy surface is developed. Definitive callus of course remains and goes through the corticization process also.

There is no difference in actual speed of development of these stages in different areas or fractures, but it is natural that a complete fracture cannot be solidly bridged so quickly as an incomplete one. Hence although the same features are to be observed in a complete as in a merely fissured fracture, and although they are to be found at the same date, the fissured or "green-stick" fracture will be completely healed in some twenty days, whereas a complete long bone fracture may, after the elapse of that time, show large masses of heaped-up lava-like callus with an as yet unbridged gap. An impacted fracture, say of a vertebral body, may be healed in thirteen days.

Inequality of vigor in repair is characteristic of the several parts of any fracture. In certain specimens this can be directly referred to bone damage by stress or strain at the actual instant of fracture, but in others the probable cause is more obscure.

Where periosteum is elevated from the bone adjacent to a fracture the bone oftentimes is diminished in vitality, shows no erosion and takes no active part in repair, although it is not dead and becomes ultimately passively incorporated in the new structural bone. It must not be inferred that the raised periosteum develops new bone. As a rule the cambium layer is destroyed and no new bone is formed at or over the stripped surface. Such instances are

found more frequently in rib fractures than in long bones and they never occur in vertebræ so far as the Reserve collection shows.

Free movement of fragments does not inhibit the normal repair process, but if fractured ends of low vitality rub against each other, and bone fragments cannot rub against each other without becoming reduced in vitality, friction facets speedily develop similar to the occlusal and interproximate facets on the teeth. Such facets develop within two weeks after fracture and are usually described as polished or eburnated areas. These are found most often in rib fractures but may appear in long bones. We have never seen them in fractured vertebræ.

The thin cortex of ribs and vertebræ results in entire absence of a type of comminuted fragment common in long bone fractures, namely the fragment of dense compact bone. Such fragments or parts of them may be reduced in vitality owing to the raising of the periosteum yet not killed. They show no activity in repair, but become passively a part of the new structural bone. Round these fragments, or areas if they be not separated from the main fragments, a fenestration usually develops in the external or ensheathing callus at the bottom of which the bone of diminished vitality can be seen.

Endosteum or cancellous tissue is of great importance in bone repair. Compact tissue takes but little part compared with endosteum and cambium layer in the formation of new bone; it acts as the scaffolding upon which the new bone is laid down. Where cancellous tissue is relatively most abundant and mobility feeble or absent, repair is quickest, namely in vertebræ, fissured and "greenstick" fractures.

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# THE JOINT COMPLICATIONS OF ACUTE OSTEOMYELITIS OR ACUTE EPIPHYSITIS

AND THE PRINCIPLES UNDERLYING THEIR TREATMENT

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IN instances of acute osteomyelitis, I have observed the focus of infection spreading into a joint. The mechanism of this secondary involvement is a manifold one.

1. In many of the cases the infection travels into the joint through the lymphatic channels. Under such conditions an effusion of serous fluid occurs in the joint, which at first is free from organisms but in which organisms can presently be demonstrated. Actual suppuration follows unless because of efficient treatment or other apparent or obscure cause the original focus begins to retrogress, becomes localized and goes on to healing. Sometimes the joint effusion stops just short of the bacteria-carrying stage and after remaining so for a variable time it eventually disappears spontaneously. Small "sympathetic" effusions of this kind quite commonly accompany foci of osteomyelitis which are close to a joint.

2. When the fixation point for the thrombus-embolus formation occurs in the bony structures entering into the architecture of a joint, any joint infection which follows is secondary to the focus in the bone by direct extension of the infection. The anatomical groundwork and the pathological changes which enter into the mechanism of these forms of infection have been previously described and will not be repeated here. Only those parts are summarized which have important bearings on the treatment of joint infection complicating osteomyelitis or epiphysitis.

In children (and young adults) the fixation point is commonly in the neighborhood of an epiphyseal line. Anatomically a number of possibilities are present depending upon the relationship of the local focus of infection in the bone to the joint capsule and the reflection of the synovial membrane. In some of the cases the local focus in the bone lies altogether outside of the joint interior; in others it lies outside of the joint interior only partially; in still others it lies altogether within the joint. This relationship is especially important in cases of epiphysitis and the observable clinical possibilities are as follows:

A. An epiphysitis develops with or without abscess formation, and during the entire course of the infection there is no demonstrable evidence pointing to involvement of the joint. The physical basis for this naturally lies in the location of the fixation point in that part of an epiphysis which is entirely outside the joint capsule.

B. An epiphysitis develops with or without abscess formation and the clinical signs of joint involvement come only later. If this should appear

before any operative incision, it indicates that the fixation point was originally situated in a part of an epiphysis which was outside the joint and that joint involvement took place because of the spread of the infection into that portion of the epiphysis which lay within the joint or because secondary sequestration opened a path into the joint. If the signs of joint involvement came after incision, the possibility is always present that the latter was due to the operative intervention, either accidentally or, perhaps, purposefully.

C. An acute joint infection develops and at operation it is possible to demonstrate a focus of infection in that part of the epiphysis which lies within the interior of the joint. It is immaterial whether the given epiphysis lies wholly or partially within the joint; the focus of infection is in that part of it which lies within the joint.

3. In a focus of infection in a bone and near one of its articular extremities it can happen that the gradual extension of the infection in the cancellous and cortical tissue results in more and more destruction of bone until a tract forms leading into the interior of the joint. I have been able to demonstrate this lesion several times during the course of an operation. The clinical course suggests that in some of the cases the bone lesion is a relatively minor one and had, perhaps, preëxisted for some time, and that an acute rupture takes place into the joint with the sudden development of high fever, with or without chills, and other signs of an acute infection of severe grade. Positive blood cultures are not common under such conditions. Commonly the bone lesion is not recognizable in the clinical picture; the joint infection is dominant. In other cases the development of the bone fistula into the joint is a gradual one and is not accompanied by signs of any acute new lesion, or of the exacerbation of a previously existing one; frequently, indeed, the arthritis is seen to develop slowly during the course of the post-operative dressings on an osteomyelitis wound nearby. In some of these cases it is possible to demonstrate at operation that the bone tissue intervening between the joint surface and the bone focus is carious, by the ease with which an ordinary probe can pass through it and by the macroscopic and microscopic appearances of the tissue.

4. During the course of an operation I have, on several occasions, been able to pass a probe from an extra-articular abscess directly into a joint. As will be pointed out later, perforation of a suppurating joint frequently occurs and the end-result would be indistinguishable from a lesion resulting from the perforation of an external abscess into the joint. However, in my experience, several of these were distinctly subperiosteal types of abscesses situated at the extremity of a bone and close to the joint and for that reason I am of the opinion that the direction of the perforating process was inward into the joint.

5. It is possible for both bone and joint to be simultaneously involved because of the formation of more than one fixation point. I am convinced that this is a common occurrence.

## THE JOINT COMPLICATIONS OF ACUTE OSTEOMYELITIS

In actual practice it is found that the relation of the local joint lesion to any general infection (bacteriæmia) can be of three clinical varieties:

a. In the first variety a focus is present in one of the joints with well-marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteriæmia is not present. The physical basis for this variety lies (a) in a primary and temporary bacteriæmia; (b) in the development of a fixation point in a joint, and (c) in the subsequent spontaneous disappearance of the bacteriæmia.

b. In the second variety, a well-marked focus is present in one of the joints with abundant local signs and symptoms and, in addition, there are clinical indications of a bacteriæmia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteriæmia by constantly feeding into the blood stream a comparatively small number of viable organisms. It must be remembered that any of these cases may at any time pass into the third group.

c. The clinical picture of the cases in this group is that of a profound general infection. A local joint focus is either not demonstrable at all because of the paucity of local signs and symptoms, or because the latter are hidden in the profound intoxication; or, if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis for the clinical picture lies in an extreme and severe general blood infection with highly virulent organisms, in which the bacteria are being fed into, and, in addition, are rapidly multiplying in the blood stream, because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The presence of the infected thrombus-embolus formation (fixation point) forms a negligible factor and the few organisms that are derived from this source play only a primary and inciting part in the production of the bacteriæmia; the subsequent multiplication in the blood stream depends on other factors, the most important of which lie in the high virulence of the infecting organism and in the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation plays a very minor rôle in the production of any part of the clinical picture. Usually the local pathologic-anatomic picture in the given joint is not in an advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

In actual disease it seems certain that the cases differentiated in these groups form progressive stages each from the next preceding group. A case in group a, may pass into group b; and, conversely, a case in group b having been appropriately treated, may retrogress into group a, as it proceeds to healing and recovery. These interchanges are constantly occurring in clinical surgery. A case in group b may pass into group c, as previously noted;

usually under such conditions there is a continued progression until the eventual fatality. In actual practice cases in group c must necessarily first pass through the stages indicated by groups a and b; the time interval may be so short, however, owing to the virulence of the infecting organism, or the relative non-resistance of the subject, as to make these stages unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in group 3 in this way. In many cases characteristics can be distinguished which belong to both group b and group c, and so far as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations. I have never seen a case in group 3 retrogress spontaneously into group b; it seems almost impossible to believe that such retrogression can ever occur.

It is a matter of great difficulty to integrate properly the bacteriæmia or general infection between (a) any demonstrable primary lesion (such, for instance, as a thrombosis of the lateral sinus, or a furuncle of the skin, etc.); (b) the secondary bone lesion (for instance, an acute epiphysitis in one of the extremities of a long bone, or an osteomyelitis of one of the small bones of the wrist or foot, etc.); and (c) the complicating joint infection. The following general rules can be used as clinical guides:

a. In many cases the primary lesion (furuncle of the skin, etc.) has entirely healed and is removed from consideration as a factor. The cases subsidiary to a thrombosis of the lateral sinus are difficult to interpret properly. As a general rule if the sinus operation has been properly done and the jugular vein has been efficiently tied, any subsequent bacteriæmia should be referred elsewhere than to the ear condition. This rule will be found to be generally true. The only exceptions include those comparatively rare cases in which the thrombus formation in the lateral sinus spreads along the petrosal branches.

b. In any case the bone lesion plays a most important part in the maintenance of the bacteriæmia. In actual practice the proof of this relationship is in the last analysis, based upon the therapeutic test (eradication of the bone focus) according to rules summarized on a previous occasion (*ANNALS OF SURGERY*, 1927, March, 428). This practical test is important especially in post-operative cases and when the primary lesion is obscure. When the primary lesion is demonstrable, the interpretation becomes a matter of exclusion.

When the bacteriological agent of the existing infection belongs in the staphylococcus group a bone lesion is always to be assumed.

c. Cases of joint infection produced by organisms of the pneumococcus or streptococcus groups are as a rule unassociated with bone lesions and in some of these positive blood cultures are obtained. In these instances the bacteriæmia should be used as an indication that the primary lesion (such, for instance, as a streptococcus tonsillitis, or a pneumococcus pneumonia, etc.) to which the joint lesion is secondary still exists in a more or less active state.

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As a matter of fact, under such conditions the positive cultures are usually obtained in a comparatively early state of development of the primary and secondary lesions and disappear very shortly.

Joint infections occur as subsidiary lesions during severe bacteriæmias and general infections in which a bacterial endocarditis forms and becomes the main focus of distribution. Under such conditions bone lesions do not occur as intervening lesions between the bacteriæmia and the joint infection. These are usually the severest forms of general infection and the prognoses are extremely bad.

*The Treatment of the Local Joint Lesion.*—The treatment of the local lesion should be based (1) upon a consideration of the mechanism by which such foci are produced; (2) upon the character and complexity of the lesion which is produced, as determined by the available knowledge and röntgenographic evidence, especially as regards the associated osteomyelitis or epiphysitis; and (3) in accordance with the magnitude of the infection\* in association with the absence or presence of a bacteriæmia. Multiple joint foci should be treated individually along similar lines and in accordance with the viewpoints expressed.

A. Other things being equal, the absence of a demonstrable bacteriæmia or general blood infection indicates that a conservative attitude can be assumed in deciding the correct method of surgical treatment of the local lesion. The immediate importance of this conservative attitude comprises: (1) The avoidance of any operative intervention in many cases. Our best examples have been in the hips. Quite commonly these cases complicate the sinus thrombosis which follows an acute mastoiditis; and quite frequently the joint infection is secondary to a lesion in one or more of the epiphyses of the upper end of the femur. The clinical manifestations are largely due to the joint involvement. Even in the presence of high fever—frequently protracted for considerable periods of time—and of other signs of toxæmia, conservative forms of treatment are always indicated. The indications can be adequately met by traction and immobilization and the subsequent results have demonstrated that the natural antibacterial and healing forces of the body have been ample to control the general infection and the local focus and to bring about an efficient healing. The late results as regards function have been very good; curtailment of the normal ranges of motion have been inconsequential and of minor degrees or have been reduced to a minimum.

(2) A much less severe—frequently, indeed, a minor primary operation in the cases in which the operation should prove necessary.

(3) The much less chance of the spreading of the thrombo-phlebitic or thrombo-arteritic lesion with all the consequences hereinbefore outlined. This advantage, valuable beyond anything else, is guarded by the avoidance

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\* The discussion of this aspect of the subject will not be repeated here. Cf. *ANNALS OF SURGERY*, March, 1927.

of any operative intervention and is least disturbed by the method of operative intervention indicated—the introduction of simple drainage.

(4) The conservation of important bone tissue. This is of maximum importance in any component which enters into the structure of a joint.

In the conservative treatment of joint infection complicating acute osteomyelitis, reliance should be placed upon traction and immobilization in association with general supportive measures, good food and efficient nursing. Later when the acuteness of the joint lesion has subsided gentle massage and extremely gentle passive and active motion should be instituted. In lower extremity lesions weight-bearing should not be allowed until every sign of activity in the joint lesion has been eliminated and all symptoms have disappeared. An efficient brace should be made and should be worn by the patient for from six months to one year. Under this régime I have seen repeatedly a gradual amelioration of the general and local symptoms and signs and a final healing of the lesion in the joint.

The only operative indication to meet under this plan of treatment is the introduction of adequate drainage when the local conditions call for it. Under the circumstances the necessity for operation arises only because of an excessive accumulation of purulent matter and the latter collects (a) within the interior of the neighboring joint, (b) exterior to it under the periosteum, or in the fascial planes of the limb, or (c) in more than one of these locations either simultaneously or as developments the one from the other. When the purulent collection is restricted to the interior of the joint and the joint capsule remains intact, operation is not usually or necessarily indicated. Collections of pus exterior to the joint, whether produced by perforation of the joint capsule or as a subperiosteal abscess, etc., must usually be incised and properly drained. In many cases this is all that is needed.

Perforation of the joint capsule is a fairly common complication. Extra-articular abscesses then form which usually follow certain definite courses in their development depending on the individual joint and its anatomical relations. It is well to know these. It happens not so very rarely that patients are admitted to the hospital with larger or smaller abscesses between the fascial planes in the depths of the extremities which do not heal in the usually expected way after they have been properly incised and drained. The persistence of an abundant purulent discharge from the wounds make it apparent finally that the discharge is being fed from some primary focus which proves almost always to be a suppurative arthritis in the neighboring joint with or without an associated osteomyelitis. It is a curious clinical fact that in some of the cases the subjective symptoms have either not been referred to the given joint, or that the objective relationship is not recognized. Healing occurs finally only when the primary foci—joint, or bone, or both of these—have been properly attended to.

The more characteristic of these lesions follow:

1. Suppuration within the knee-joint perforates through the posterior

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surface of the capsule and spreads out in the popliteal space; further extension occurs downward between both heads of the gastrocnemius muscle and then between the belly of the latter and the underlying soleus muscle. A large abscess then forms in the calf of the leg. In addition to incising the abscess in the calf, the knee-joint itself should be properly drained on both its lateral aspects anteriorly.

2. Suppuration within the hip-joint follows one of three paths in perforating through its capsule. The perforation never occurs through the substance of the ileo-femoral (Y) ligament but on either side of it.

a. When perforation occurs at the inner aspect of the Y ligamentum pus collects between the adductor muscles and the abscess points in the fold of the groin over the pubic ramus. Drainage should be established at this point in addition to the classical method of draining the hip-joint proper.

b. When the perforation occurs on the outer aspect of the Y ligamentum pus collects exterior to the joint on its outer side and between the rectus, the sartorius and the tensor fascia femoris muscles. In the interval between the latter two muscles the pus perforates the deep fascia of the thigh and a large subcutaneous abscess forms lying on the outer side of the thigh and extending around to its anterior and posterior surfaces. Incision of the abscess should be carried high enough so that drainage can be established into the hip-joint in the usual way.

c. Perforation through the posterior part of the capsule occurs in the neighborhood of the cotyloid notch. An abscess forms exterior to the joint in and between the glutei muscles. It is difficult to drain the hip-joint through its posterior aspect and it is better to open the hip-joint in the classical way on its outer and anterior aspects in addition to draining the external abscess in the buttock.

Suppuration within the hip-joint perforates not so rarely through the centre of the acetabulum. A subperiosteal abscess then forms on the pelvic side of the innominate bone opposite the acetabulum which is easily palpated by rectum. Extension occurs under the pelvic fascia and a pelvic abscess results; or extension occurs in an upward direction toward the iliac fossa where the abscess points extraperitoneally above Poupart's ligamentum.

3. The point of election for perforation of the shoulder-joint is on its anterior aspect. The perforation occurs internal to the lesser tuberosity and the abscess spreads out beneath the tendon of the subscapularis muscle. The tumefaction is best felt in the axilla. Or it comes forward between the deltoid and pectoralis major muscles and points in the general neighborhood between the latter two muscles. A large subcutaneous abscess sometimes forms which covers the outer aspect of the shoulder.

4. In the small joints of the hand and foot, perforation usually occurs on the anterior or flexor surface of the joints.

In a general way the actual methods of introducing drainage follow approved surgical principles and comprise (a) the simple opening of abscesses in the soft parts; (b) the opening and drainage of subperiosteal abscesses;

and (c) the various forms of arthrotomy and drainage for the individual joints. In given cases and under proper circumstances the use of Dakin's solution forms an important part of the after treatment of the operative wounds. The Willems method of treatment does not find a place in the treatment of the forms of suppurative arthritis which complicate acute osteomyelitis or acute epiphysitis. Theoretically, this method might be of value in those comparatively few cases in which the joint exudation approaches the type referred to as "sympathetic effusion," in which the latter is bacteriologically sterile, and in which diseased bone does not reach into the interior of the joint, in such cases we have come to believe that operation upon the joint is not indicated. Similar efforts and care should, however, be exercised in the after care of the operated cases as was described in the non-operative treatment, comprising traction and immobilization, general care and nursing, subsequent massage and gradual assumption of motion, the elimination of weight-bearing and the prolonged use of a brace.

The treatment of the associated acute osteomyelitis or acute epiphysitis follows the general rules and indications summarized in a previous communication (*ANNALS OF SURGERY*, March, 1927). No discrepancies of any kind will be found between the general rules by which the bone lesions and the joint complications are to be treated; as a general rule the indications and methods are so closely interrelated that the adequate treatment of the one will include the efficient treatment of the other.

The indications and opportunities for secondary operations upon these cases are relatively few because of a number of reasons: (1) These cases are most commonly found in young children in whom the capabilities for natural spontaneous regression and healing are at their maximum. (2) Most of these joint infections complicate lesions in the epiphyses. Owing to the structure of the latter the bone foci are necessarily limited in size; the resulting sequestra are small; and within the confines of a joint absorption of the latter is a phenomenon of extraordinary rapidity. (3) Many times there is no indication for operation because the sequestra which do form are relatively small and are easily discharged from the wounds made originally for drainage. Thereafter the wounds close spontaneously.

In the exceptional case the persistence of necrotic bone tissue makes it necessary to perform secondary sequestrotomy. Only as much healthy bone or involucrum should be removed as to enable one adequately to remove the sequestrum. The main care is not to cause undue mutilation and to prevent the spread of the thrombo-phlebitis inasmuch as this is the chief cause for the subsequent exacerbations or recrudescences in the same focus or in the production of other foci. The resulting wounds should not be sutured and should be allowed to heal from the bottom, either with or without the aid of sterilization by the Carrel-Dakin method.

The results of this conservative plan of treatment for cases of joint infection complicating acute osteomyelitis (including epiphysitis) have been



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very good in our experience when this plan can be consistently followed. There has been a greater usefulness because of a greater conservation of important bone structures, because of less profound changes in the interior of the joints and in the soft parts surrounding them and because of milder disturbances in the range of joint motion.

B. Other things being equal, the presence of a demonstrable bacteriæmia or general blood infection indicates a dangerous and possibly progressive lesion and bespeaks an urgency of effort which seeks to remove the guilty local focus as early and as completely as possible before irreparable damage is done by the spreading of the infection to the endocardium or other important organ or locality. All of the information classified in the previous part of this and in other papers as regards the clinical and the therapeutic significance of a bacteriæmia or general blood infection from the surgical standpoint, especially as it accompanies an acute osteomyelitis or epiphysitis, come into play at this time and judgments should be based and indications met accordingly. These statements and those hereinafter made hold true except in the very mildest cases of bacteriæmia; in these a conservative attitude along the lines hereinbefore indicated is permissible as it is found clinically that these cases behave practically in much the same way as the cases with sterile blood cultures. A policy of extreme watchfulness is, however, highly important until the bacteriæmia disappears. The subsequent discussion should be understood in the light of this reservation.

The important indication is to remove the local focus of osteomyelitis or epiphysitis to which the joint infection is secondary as completely as possible. Conservatism should be replaced by the radical removal of bone tissue frequently into healthy areas. It is found clinically, however, that this indication cannot always be adequately met and there are times and localities in which the radical removal of the thrombo-phlebitic foci of osteomyelitis (or epiphysitis) is not technically feasible. This is so because of a number of factors:

1. The impossibility of determining clinically, or of demarcating accurately even upon operative exposure, the exact extent of disease in any given bone is an important characteristic of the early stages of the development of a focus or infection in osseous tissue and prevents one from eradicating the latter adequately. The physical basis for this exists in the manner and extent of intraosseous vascular clotting, of the consequent disturbance of intraosseous circulation and of the capabilities for collateral blood supply. Owing to the physical structure of the bone, changes are not visible to the unaided eye or on an X-ray photograph at these comparatively early stages of the development of the focus, *i.e.*, at the time these cases are usually operated upon. Röntgenological evidence of all these structural changes only become recognizable (a) after the bone cells have died and after the bone matrix has begun to sequester, in which case the discriminating shadows forming lines of demarcation and areas of absorption, rarefaction find their physical basis in the disappearance of lime salts; and (2) after

new bone—involucrum—has been deposited around the sequestered portions, in which case the discriminatory shadows are due to the deposition of new lime-bearing tissue; both of these physical conditions are the products of long-continued activity of processes of disease and of processes of healing and only become recognizable at a late stage. Röntgenological evidences of the "first appearances and of the subsequent development" of a focus of osteomyelitis in an epiphysis, are very liable to mislead one unless they are properly interpreted.

2. Epiphyses are commonly important component parts of joint structures. Under the circumstances the times and localities in which radical removal of the thrombo-phlebitic focus in the epiphysis is not technically possible are frequent. In addition the immediate proximity to important conjugal cartilages, and the wish to conserve as much as possible of the skeletal structure in order to preserve as much as possible of the normal growth and functions, makes undesirable any radical removal of the focus of infection in an epiphysis.

In actual practice these two criteria frequently disturb and prevent ideal methods of treatment of the local epiphyseal lesion in the presence of a bacteriemia. As much as possible should, however, be done in the way of removing the entire focus; ample drainage should be secured in addition as the next best thing; and a good deal must be entrusted to nature's efforts in spontaneously dissipating the bacteriemia. In actual practice this incomplete method of treatment works out fairly well in the milder and moderately severe type of bacteriemia; spontaneous regression and disappearance of the general infection frequently takes place and the disease continues as if no bacteriemia had existed. In the severe type of general blood infection, one is frequently compelled to disregard anatomical structure and subsequent disturbance of function and to proceed ruthlessly to remove the entire focus of infection; the question of amputation frequently comes up; success does not always follow. In the most severe type of infection—as indicated in a previous part of this discussion—it should be recognized that operation is futile.

The experiences upon which the discussion in this communication is based is derived from clinical observations upon patients admitted to the service of Dr. A. V. Moschcowitz at Mount Sinai Hospital and upon patients in my own private practice. I am indebted to Doctor Moschcowitz for permission to carry on some of these observations upon the patients admitted to his service.

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# THE SIMULATION OF GALL-BLADDER DISEASE BY INTERCOSTAL NEURALGIA OF THE ABDOMINAL WALL\*

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WHEN the pain and tenderness of intercostal neuralgia involve the upper right abdomen they may closely simulate, and may be easily mistaken for the pain and tenderness of gall-bladder disease.

In an earlier paper I discussed "Intercostal Neuralgia as a Cause of Abdominal Pain and Tenderness"<sup>1</sup> and I described tests to differentiate parietal neuralgia from the intra-abdominal lesions which it simulates. Pending a suggestion by some one of a more suitable appellation, I employ the term "intercostal neuralgia" to include every condition that may give rise to pain and tenderness of the intercostal nerves. Clinicians seldom consider the possibility of abdominal pain and tenderness being located in the abdominal wall itself with the result that a very common parietal affection—intercostal neuralgia—is erroneously diagnosed as an intra-abdominal, pelvic, or genito-urinary lesion.

The entire nerve supply of the anterior abdominal wall comes from the sixth to the twelfth intercostal and first lumbar nerves. Neuralgia of the tenth, eleventh, or twelfth intercostal or first lumbar nerve on the right side is commonly mistaken for appendicitis, as I have endeavored to explain in two recent papers on "Chronic"<sup>2</sup> and "Acute"<sup>3</sup> "Pseudo-appendicitis." These three earlier papers discuss many points that are pertinent to the subject of gall-bladder disease, but time and space forbid their repetition here.

The sixth to the tenth right intercostal nerves supply the right upper quadrant of the anterior abdominal wall. Painful affections of these nerves—both acute and chronic—are incredibly common and cause pain and tenderness which are frequently mistaken for acute or chronic biliary lesions. Many writers state that the clinical diagnosis of gall-bladder disease is easily made on the history and physical examination; but my own observations indicate that—with the exception of indigestion, jaundice and palpable gall-bladder—the history, symptoms and bedside signs of gall-bladder disease and biliary colic can be simulated perfectly by painful affections of the intercostal nerves.

There are many diagnostic fallacies shared in common by the gall-bladder and the vermiform appendix. Chronic inflammation incident to advancing age occurs in both these organs with such frequency that it should be regarded as an almost universal finding beyond middle life. In a paper on "The Gall-bladder of 1926"<sup>4</sup> Charles H. Mayo states that there are few necropsies on persons aged forty or over in which the appendix is normal and that the

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same also holds true for the liver and gall-bladder. These facts are coming into general recognition in the case of the appendix, but are largely ignored in the case of the gall-bladder. Numerous writers assert that the real post-operative test as to the correctness of a pre-operative diagnosis of chronic appendicitis must not be based upon what the microscope shows in the way of chronic changes but should be determined by the clinical test of whether

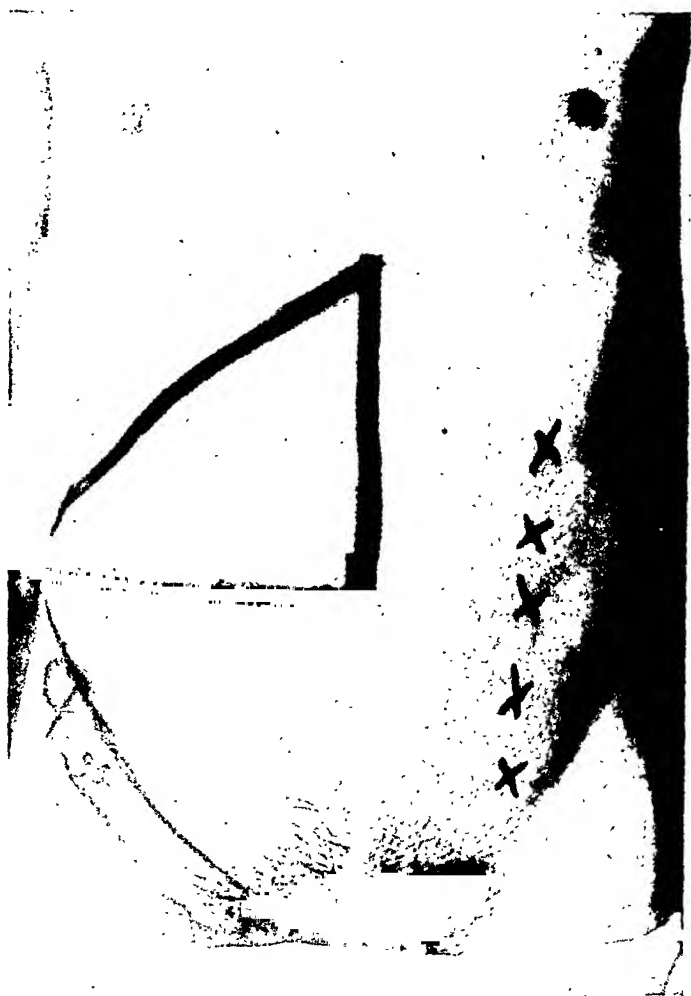


FIG. 1.—Biliary and appendiceal triangles. The rectangle is the upper thigh area of hyperesthesia due to neuralgia of the right ilio-inguinal nerve. Single cross is point of election for testing for ilio-inguinal nerve tenderness in thigh. Circle is the anterior superior iliac spine. Row of crosses represent "tender points" along left rectus muscle.

or not the symptoms for which the patient sought relief are cured or greatly benefited by the appendectomy. I have not seen any analogous statement pertaining to the gall-bladder, although failure to relieve symptoms is a frequent sequence of cholecystectomy. In other words, the mere finding of a grossly or microscopically diseased appendix or gall-bladder at operation does not prove that the pre-operative symptoms in their vicinity were caused by these organs and will be relieved by their removal. In my experience the commonest cause of abdominal pain and tenderness which are not relieved by appendectomy or cholecystectomy is intercostal neuralgia. It is also my experience that in the majority of the

patients who are referred to me with a diagnosis of gall-bladder disease, the pain and tenderness are parietal rather than intra-abdominal.

The right half of the abdomen may be arbitrarily divided into two triangles. (Fig. 1.) The lower or appendiceal triangle is bounded by lines extending between the umbilicus, the crest of the right ileum and the pubes; and the upper or biliary triangle by lines joining the umbilicus, the tip of the xyphoid and the right iliac crest. The parietal pain and tenderness of intercostal neuralgia are commonly mistaken for appendiceal symptoms when they occur in the lower triangle, and for biliary symptoms when they occur in the upper

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triangle. Many surgeons who have learned that appendectomy will not cure the chronic pain and tenderness of the appendiceal triangle have not yet learned that the same chronic pain and tenderness of the upper triangle are not cured by biliary operations.

The recognition of the presence of intercostal neuralgia in the biliary triangle is very important from several different angles. (1) Parietal neuralgia may be the only cause for the patient's symptoms and a biliary operation is therefore contra-indicated. (2) Parietal neuralgia may accompany and mask serious gall-bladder disease requiring the utmost diagnostic skill to detect the latter lesion. (3) Biliary operations as a rule do not cure parietal neuralgia, hence patients should be warned before operation that the neuralgia-symptoms will persist and require special treatment, otherwise they and their physicians regard the late results as surgical failures. Theoretically, the removal of a toxic focus by cholecystectomy might be expected to cure parietal neuralgia, but unfortunately it commonly fails to do so. (4) An exacerbation in neuralgia symptoms may be anticipated during the first four or five days after a biliary operation possibly due to over-extension of the spine on the operating table. Recognition of excessive post-operative pain and tenderness being due to parietal neuralgia will save the surgeon from anxiety during the first day or two regarding a possible beginning diffuse peritonitis and on later days will save the patient from being regarded as a neurotic or malingerer.

The spontaneous parietal pain of intercostal neuralgia varies greatly in intensity in different patients and in the same patient at different times. Even when all the intercostal nerves of one or both sides are affected the patients seldom complain of spontaneous pain except over the soft anterior walls of the abdomen. Female patients, however, may complain of neuralgic pain in one or both breasts and patients of both sexes may complain of spontaneous pain at the angle of the right scapula quite similar to the referred pain of biliary colic.

The intercostal nerve irritation may be so slight that the patient may not have any spontaneous abdominal pain, even when the objective tests I shall describe are all positive. In exceptional instances the pain of neuralgia may be as intense as the most severe colic or strangulation. In between these extremes all grades of severity of spontaneous pain are encountered.

Spontaneous pain may be so constant as to be present every waking moment for weeks, months or years, or it may occur as intermittent attacks lasting hours or days with days or weeks of freedom quite similar to mild or severe attacks of biliary colic irrespective of whether the gall-bladder is present or has been excised. The acute attacks may be apparently causeless or may follow active exercise or a focal infection, especially of the upper respiratory tract. In the last event there is often associated a low grade of transient fever and leucocytosis, and if these occur in a patient whose neuralgic pain is manifested both in the biliary triangle and in the right subscapular region, the similarity to subacute cholecystitis is very striking.

In several recent papers emphasis has been placed on the biliary distress

commonly occurring for the first time during the puerperium. I have seen several cases of undoubted intercostal neuralgia in which the first symptoms arose during the puerperium. I believe neuralgia is most commonly due to various distortions of the spine resulting from many causes, including in a minor way pregnancy and labor.

Like biliary distress, the pain of intercostal neuralgia may come on during the sleeping hours and is then often due to a mattress or springs which cause harmful strain on the spine and is prevented by the patient changing to another bed.

Intercostal neuralgia may be encountered in visceroptotic individuals and some of the indigestion symptoms due to visceroptosis or intestinal stasis are quite similar to those of gall-bladder disease. Flatulence and belching are often caused by gall-bladder disease, but the frequent failure of cholecystectomy to abolish them indicates they are often due to other lesions. I concur in Judd's statement that "very few normal persons are entirely free from some of the symptoms of dyspepsia." Furthermore, I have gained the impression but am by no means positive, that upper abdominal distress following a full meal and relieved by vomiting may be due to parietal intercostal neuralgia. Patients with neuralgia are frequently encountered who cannot tolerate belts, corsets, or even snug-fitting clothing because of hypersensitiveness of the skin. A similar neuralgic hypersensitiveness of the epigastric anterior parietal peritoneum might render the pressure of a full stomach intolerable and relief would be obtained by vomiting.

An earlier jaundice may have been due to a catarrhal inflammation and therefore without significance in the diagnosis of the patient's present condition. Again many patients confuse jaundice with sallow complexion.

The points of similarity that have been cited are enough to indicate that history and subjective symptoms in the absence of jaundice or palpable gall-bladder are not very helpful in arriving at a correct differential diagnosis between biliary disease and parietal neuralgia. Furthermore these two affections cannot be differentiated by the customary methods of bedside physical examination.

The usual practice of conducting abdominal palpation only when the muscles are fully relaxed fails to indicate the superficial location of parietal tenderness in intercostal neuralgia and leads very commonly to the erroneous assumption that the tenderness is caused by a lesion in an underlying viscus. I have devised a simple bedside test to detect tenderness of the abdominal parieties. Every patient in whom abdominal tenderness is found should be subjected to this test. The patient is instructed to hold his abdominal muscles as tense as possible by contracting his diaphragm or by raising both heels from the bed with knees extended while the examiner makes firm abdominal palpation. Any tenderness thus elicited will be parietal in location. Tenderness elicited over relaxed abdominal muscles may be either parietal or intra-abdominal in location.

By far the most frequent cause of parietal tenderness is intercostal

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neuralgia. In my three earlier papers I detailed extensive tests to demonstrate the presence of intercostal neuralgia. Briefly they consist as a rule in finding: (1) Tenderness to palpation over voluntarily tensed muscles over more or less of—or even extending beyond—the biliary triangle; (2) tenderness over the same triangular area elicited by pinching a liberal fold of abdominal skin and fat between the thumb and two first fingers; and (3) tenderness along some or all the nerve trunks in the sixth to the tenth right intercostal spaces.

Neuralgia often is not limited to the sixth to tenth intercostal nerves on the right side and in that event there will be a corresponding increase beyond the biliary triangle over which tenderness can be elicited by each of the three above tests. All twelve intercostal and the first lumbar nerves or any lesser number of them may be involved either unilaterally or bilaterally. When either or both the twelfth intercostal and first lumbar nerves are involved there will be found a characteristic area of palpation ten-

Fig. 2.—Dissection to demonstrate branches of intercostal nerves where they enter the rectus abdominis muscle. (From Spalteholz.)



derness over the buttock on the same side corresponding to the area of terminal distribution of the iliac branches of the twelfth intercostal, iliohypogastric and ilio-inguinal nerves. Neuralgia of the ilio-inguinal nerve produces tenderness in the upper thigh. (Fig. 1.) When the topmost intercostal nerves are affected pinch tenderness of skin and fat will be found in the arm near the posterior axillary fold in the area supplied by filaments of the second intercostal which are carried in the intercosto-humeral nerve.

In those cases of parietal neuralgia in which palpation tenderness is fairly evenly diffused over part or all of the biliary triangle, there will generally be found certain "tender points" (Fig. 1), exhibiting much more profound tenderness along the outer edge of the right rectus muscle. These "tender points" probably correspond to the points (Fig. 2) at which

intercostal nerve branches perforate the transversalis fascia and aponeurosis to enter the rectus muscle. One of these "tender points" is commonly found at the tip of the ninth or tenth costal cartilage and by the usual method of palpation is very apt to be mistaken for the localized tenderness of a sensitive gall-bladder. A neuralgic "tender point" situated at or near the right costal arch will give a perfect and characteristically positive response to Murphy's gall-bladder tenderness test. This test consists of "hooking" the fingers under the costal arch while the patient attempts a deep inspiration. A sudden painful cessation of inspiration is supposed to indicate the presence of a tender gall-bladder which has been forced downward against the examiner's fingers. The sharply localized area of tenderness demonstrated by slight shifts of the position of the fingers in making this test has heretofore been regarded as confirmation of the tenderness being confined to the gall-bladder. A parietal "tender point" of intercostal neuralgia will give exactly the same response as a tender gall-bladder to the above tests. I have repeatedly demonstrated to students that the Murphy test will give a positive response at the left costal arch and at the right costal arch even after cholecystectomy when the middle finger of the palpating hand is placed exactly upon one of the "tender points" of intercostal neuralgia while the patient attempts deep inspiration. Although the examiner's fingers are held in a fixed position in making this test, yet more pressure is exerted upon the "tender point" because it is forced against the middle finger by the inspiratory effort. Every observant surgeon is aware that the position of the gall-bladder as revealed by operation very frequently is far removed from the site of pre-operative localized tenderness as determined by a positive Murphy test. In such instances the localized tenderness is due to a neuralgic "tender point" in the abdominal parietes.

That the localized tenderness of intercostal neuralgia is in and not beneath the parietes can be shown by the examiner keeping the end of his middle finger exactly but gently on the sensitive area disclosed by the Murphy test until the patient voluntarily makes and holds his abdominal muscles tense and then by reapplying finger pressure the tenderness demonstrated must be parietal because the tense abdominal muscles prevent the finger exerting pressure on the gall-bladder.

That the tenderness of the same "tender point" or of some other "tender point" further down alongside the right rectus (or if the neuralgia is bilateral alongside the left rectus) is parietal, can also be demonstrated by the examiner indenting the abdominal wall with the end of his middle finger to a depth just short of causing pain, and holding his finger rigidly at that depth while the patient endeavors to take a deep inspiration. The pain caused by forcing the "tender point" against the fixed finger will cause the same sudden suspension of inspiration as in the Murphy test. In some cases the diffuse tenderness is so marked that interruption of the inspiratory effort



will occur at whatever point the Murphy test is applied along or near the costal arch without reference to the finger being placed on a "tender point". In those cases in which the neuralgic pain and tenderness are fully developed their parietal location can be readily determined by the various tests which have been described. At the time many patients first come under observation, however, the neuralgic pain and tenderness may be at a low ebb and the only evidence obtainable may consist of the "tender points" with or without a more diffuse area of lesser palpation tenderness within the biliary area. Under such circumstances spontaneous pain, pinch tenderness of skin and fat, and pressure tenderness of nerve trunks may be entirely absent. Palpation by finger end poking over the voluntarily tensed abdominal muscles reveals the parietal location of the tenderness even in these mild cases of neuralgia. Doubt as to the parietal location of the tenderness in any given case can be cleared up by "blocking" the affected intercostal nerve trunks with novocaine.

Failure to recognize the presence of intercostal neuralgia in the biliary region commonly leads to the error of ascribing the neuralgic pain and tenderness (1) to hysteria or other neurotic causes, or (2) to gall-bladder disease directly or, (3) to a visceroparietal-sensory reflex from gall-bladder disease.

An erroneous pre-operative diagnosis of hysteria or semi-malingering is most frequent in the cases in which the neuralgic pain and tenderness are too widespread to be accounted for by any single visceral lesion either of the gall-bladder or any other organ. An erroneous post-operative diagnosis of hysteria usually results from persistence of the neuralgic pain and tenderness after cholecystectomy.

In an interesting paper on the high percentage of unsatisfactory end results of operations on stoneless gall-bladders, Stanton<sup>5</sup> states: "Three patients after operation were found to be suffering from hysteria and not gall-bladder disease. Until we develop some pathognomonic, hysteria-proof sign for gall-bladder disease, the abdominal surgeon will probably continue to be fooled now and then by patients suffering from hysteria. The woman with hysteria and a fair knowledge of the symptomatology of gall-bladder attacks is a dangerous diagnostic possibility."

And again Stanton states: "The next group, containing fifteen cases, is made up of five cholecystostomies and ten cholecystectomies, all reporting cured or satisfactorily improved at the time of the last end result note, but in none of these cases can I demonstrate a one to one cause and effect relationship between the operation and the final result. Either final recovery took place months or years after the operation, or there have been intervening recurrent attacks of symptoms indistinguishable from those for which the patient was operated on."

In another group Stanton found: "Ten patients, when last heard from, were still suffering from abdominal symptoms similar to those for which their operation was performed." The pathologic changes recorded in the latter two groups of twenty-five not benefited by operation were not very definite.

My experience with intercostal neuralgia indicates that it was the probable affection responsible for the great majority of Stanton's twenty-eight operative failures.

Deaver and Bortz<sup>6</sup> report that: "Highly neurotic persons will often exhibit a continuance of symptoms after removal of a definitely diseased gall-bladder with or

without stones, and in this series many of the patients examined in the follow-up department, complaining of persistence of symptoms, were of this type."

Of 217 patients traced after operations for gall-stones Sculberger<sup>7</sup> found 173 free from symptoms and twenty required re-operation. He has found that the post-operative symptoms often ascribed to adhesions are frequently relieved by paravertebral injections of procain.

Of 120 patients who survived biliary operation, mainly cholecystectomies, Brentano<sup>8</sup> reports the end results as being complete cures in 71, improvement with persistence of a few painful crises in 23 and recurrence of pain in epigastrium and tenderness in gall-bladder region in 26.

Of 23 cholecystectomies for non-calculous cholecystitis Steden<sup>9</sup> reports the pains persisted in half of them and in one was so severe that a second operation was done for suspected duodenal ulcer but nothing was found. Of 164 cholecystectomies for gall-stones 56 have remained free from pain and in 24 the post-operative painful manifestations have been severe.

Judd<sup>10</sup> states that gall-bladder operations based on clinical symptoms alone are likely to fail. He has found that repeated colicky pains is a fairly common complaint among the groups of patients who were not entirely cured at the end of a five-year period following gall-bladder operations.

None of the preceding writers attempted to differentiate parietal pain from intra-abdominal pain in their cases of biliary affections.

The writers who are aware of the parietal location of tenderness in suspected gall-bladder disease are confined almost entirely to the small percentage of clinicians who believe in the viscero-parietal-sensory reflex as described by McKenzie, Head and others. The various views relative to this reflex are summarized by Akana, Greeley and Farr<sup>11</sup> in their paper on referred pain in 424 consecutive cases of gall-bladder disease confirmed by operation in all but five which were not operated upon. These three co-authors apparently did not test for superficial hyperæsthesia but based their paper on patients' statements as to the pain radiations. The pre-operative diagnosis proved erroneous in about 13 per cent. of their cases. In ten of their patients there was no pain.

In addition to pains in the epigastrium, right hypochondrium, and right back they describe pains as being referred to right testicle, to both shoulders, to the lumbar region, to the chest, across the abdomen, to right lower quadrant, to left lower quadrant, to left shoulder, to both shoulders and left arm, to the heart, to the "sides", to left hypochondrium, to the lower abdomen, and to the left lower quadrant. I do not believe that gall-bladder disease gives rise to such widespread pain in the absence of complicating peritonitis. The finding of gall-stones and suppurative or gangrenous cholecystitis at operation does not prove that distant pains are due to the biliary lesions. Unfortunately these authors do not give end results, otherwise I suspect they would find that these distant—and even many of the local—pains have persisted since operation and are due to intercostal neuralgia.

Livingston<sup>12</sup> is a staunch supporter of the viscero-parietal-sensory reflex in diseases of the appendix, gall-bladder and kidney. By "positive skin signs for gall-bladder

disease" he means "cutaneous hyperæsthesia that is present on the anterior abdominal wall, localized approximately within a two-inch radius from the tip of the ninth costal cartilage and maximal at that point. The lower limit of the hyperæsthesia does not reach to the level of the umbilicus nor does the upper limit extend upward as far as the breast, nor does it extend to the left of the midline. The method of testing consists of "a vigorous twisting pinch." Of 22 cases operated upon for "acute cholelithiasis or acute cholecystitis" "positive skin signs" were present in 20 and absent in 2. One of the negative cases had both gall-stones and kidney stones, the skin signs being negative for cholelithiasis and positive for nephrolithiasis. The second negative case was a common duct obstruction by stone with jaundice and without colic. Unfortunately Livingston does not give any details as to the pathological condition of the gall-bladders nor does he make any statements relative to the disappearance of the pains after operation.

Cope,<sup>13</sup> who believes in the viscerosensory reflex investigated cutaneous hyperæsthesia by pin-stroking and gentle pinching of the skin in 16 cases of acute disease of the biliary tract and found the skin signs positive in only six. The hypersensitive areas were not the same in any two cases and none of them corresponded to the area described by Livingston. In one of Cope's cases that gave skin signs similar to one of the six positive cases, exploratory laparotomy failed to reveal any lesion and a diagnosis of diaphragmatic pleurisy was then made although friction rubs were never heard.

I am whole-heartedly antagonistic to the theory of a diseased gall-bladder or any other abdominal viscus giving rise to a viscerosensory reflex as manifested by cutaneous hyperæsthesia of the abdominal wall. The majority of intra-abdominal lesions do not exhibit skin tenderness. The great majority of patients who have skin tenderness do not have intra-abdominal lesions of any consequence. Operations for either insignificant or gross visceral disease as a rule are not followed by permanent loss of chronic cutaneous hyperæsthesia. Transient loss or abatement of the hyperæsthesia may occur as the result of incidental rest in bed, but a follow-up for a year or more commonly demonstrates recurrence of the skin tenderness. In my opinion the occasional permanent loss of parietal tenderness after operation may rarely be due to removal of a toxic focus but much more frequently is due to factors other than the operation itself.

In every case suspected of having any intra-abdominal lesion it is important to examine the parietes by palpation over tense muscles for the signs of intercostal neuralgia. The absence of parietal tenderness in any patient complaining of abdominal pain and tenderness strongly substantiates the diagnosis of a visceral lesion. A positive Murphy test in the absence of parietal tenderness points definitely to a diseased gall-bladder, but true sub-parietal tenderness is relatively rare, even in the presence of marked disease confined to the gall-bladder. Sub-parietal tenderness is encountered more frequently in complicating peritonitis. The presence of parietal tenderness does not exclude a co-existent visceral lesion, but in arriving at the latter diagnosis the clinician should carefully consider the possibility of all the pain and tenderness being due to parietal neuralgia.

The history and bedside examination are often insufficient to establish the presence or absence of a visceral lesion, especially gall-bladder disease, when the picture is obscured by parietal neuralgia and resort must then be made

to all other available diagnostic methods. The presence of overlying parietal neuralgia very commonly prevents bedside determination of the presence or absence of gall-stones or biliary disease unless an enlarged gall-bladder can be definitely demonstrated. Under these circumstances the bedside examination needs to be supplemented by the Graham cholecystographic test, by gastro-intestinal X-ray examinations and by diagnostic bile drainage, before arriving at a final decision. Any one of these three supplementary examinations may demonstrate the presence of gall-stones or biliary disease but none of them is infallible, especially in a negative way, in all cases.

The Graham dye test may occasionally aid in visualizing gall-stones or more commonly may indicate functional disturbance either by an absent or faint shadow of the gall-bladder or by delayed disappearance of the gall-bladder shadow after the fat meal.

Röntgenological examinations may rarely demonstrate gall-stones but more commonly they disclose evidence of biliary disease indirectly by absence of lesions within the stomach and duodenum and by the presence of adhesions which distort the latter two viscera and displace them to the right.

By diagnostic bile drainage the finding of cholesterol crystals and bilirubin calcium pigment in the "B" fraction of bile fairly consistently indicates the presence of gall-stones. Failure to obtain "B" bile suggests a gall-bladder with rigid walls or full of stones or an obstruction of the cystic duct usually by stone but needs to be checked by a Graham test. The findings suggestive of non-calculous cholecystitis may consist of absence of "B" bile; or of excessive concentration of "B" bile due to abnormal stasis; or, of columnar epithelial cells, bacteria and mucus all of which are bile stained.

Unless some one of these three supplementary examinations gives very positive evidence of gall-stones or cholecystitis; or unless there is a reliable history or actual presence of jaundice; or unless an enlarged gall-bladder is demonstrable or unless constitutional and local symptoms, especially rigidity, indicate acute cholecystitis, I refrain from operation whenever I detect the presence of intercostal neuralgia in the biliary triangle regardless of the presence of what have heretofore been considered characteristic history and bedside findings of chronic or recurrent gall-bladder disease. I prefer to study those patients during an acute attack when I often find that their symptoms disappear by anæsthetization of the intercostal nerve trunks with novocaine.

Charles H. Mayo<sup>14</sup> very correctly states: "Years ago when diagnosis was less accurate the term 'neuralgia of the stomach' other than syphilitic obscured many a gall-bladder colic." The diagnostic pendulum has swung so far in the opposite direction that very few clinicians now consider the possibility of "neuralgia other than syphilitic" being the cause of symptoms in suspected gall-bladder cases. Routine pre-operative search for the signs of intercostal neuralgia will result in a decided reduction in the number of operations in stoneless gall-bladders.

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# ON PYLORIC STENOSIS AS A COMPLICATION IN CHOLELITHIASIS

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EXPERIENCE has long since taught us that vomiting and pain play an important part in the symptomatology of gall-stone disease. We also know the diagnostic importance, in many cases, of the interrelationship between these two symptoms: unlike what is commonly the case in gastric ulcer, vomiting does not usually occur at the climax of the regularly recurrent pains, temporarily easing these, but rather coincides with them in a disorderly manner without bringing about any amelioration. Besides this type of vomiting, however, vomiting occurs in rare cases of gall-stone disease as a sign of true residue in the stomach. Quite as in ulcer this is due to an organic pyloric—or duodenal—stenosis and demands, therefore, special considerations from diagnostic as well as therapeutic point of view. Papin, who, on account of a fatal case of his own, has dealt summarily with this complication—French authors seem on the whole more than others to have paid attention to this question—lays great stress upon the particular position that gall-stone cases with pyloric stenosis occupy just from the standpoint of surgical treatment.

The clinical picture presented here is to a certain extent characteristic. There is generally no question of a prolonged nor any very typical history of gall-stones. On the contrary the history is oftentimes remarkably short—one week to seven months (Friedmann's, Tuffier's, Papin's, and Venot's cases) and only exceptionally of a nature (*e.g.*, cases by Friedmann and Tuffier) that seems to point in the direction of gall-stones. Because of this and also from the generally somewhat advanced age of the patient and the debilitated condition as a result of vomiting, there is a tendency to more or less suspect cancer from the outset. Clinical examination reveals retention in a large, distended stomach. Not much is known about the character of the Röntgen findings: in Papin's case, however, it was noticed how the opaque meal passed the pylorus but accumulated in the duodenum especially in its distal part. It is the symptoms produced by the stenosis that bring the patient to seek help and which indicate operation.

The *pathological anatomy and pathogenesis* are of fairly great interest. Apart from cases where a gall-bladder, overfilled, particularly in its deeper parts, with stones is placed close to the pylorus or duodenum, and where a cholecystectomy alone causes the symptoms to subside, the following changes have been found in either the proximal or distal parts of the duodenum: 1. Considerable thickening and induration of the duodenal wall and compression of this between, on the one hand, the gall-bladder, widely and

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firmly adherent, and on the other the voluminous, abnormally firm head of the pancreas [cases by Gayet (published by Cotte) and Papin]. 2. Besides strong adhesions there may be a perforation, perhaps an obliterated fistula, between the gall-bladder and the duodenum in addition to one or more concretions in a pouch of the duodenal wall (case by Friedmann) or a wide communication between the gall-bladder and the duodenum may be occupied by a more or less voluminous stone inserted there as a wedge with one-half in the gall-bladder and the other in the intestine (Tuffier's, Okinczyc's and Goullioud's cases).

It stands to reason that the treatment in many cases must in the first place be directed toward the retention symptoms from the stomach. More particularly does this apply to patients with a much lowered condition where it is necessary to perform a gastro-enterostomy in a way that taxes the patient's strength in the least possible manner. Such cases have been related by Cotte (fatal issue) and by Venot (recovery). Tuffier did first a gastro-enterostomy (a tumor—"polypus"—was palpated in the first part of the duodenum), and at a second sitting he resected the pylorus and the aforesaid part of the duodenum as well as that portion of the gall-bladder adherent to it (in the specimen the "tumor" was found to have been a concretion located in a communication between the gall-bladder and the duodenum and protruding into the lumen of the latter). In one of Cotte's collected cases gastro-enterostomy was done first, followed at a second sitting by cholecystectomy (recovery); in one of Bircher's cases pyloroplasty and cholecystectomy were done at one and the same time. In the majority of other known cases the operation has consisted in cholecystectomy and gastro-enterostomy (possibly also duodenorrhaphy) at one sitting (one case by Friedmann, two by Bircher—recovery; one by Cotte—death) or cholecystostomy and gastro-enterostomy at one sitting (four cases by Cotte, of which two deaths) or in different stages (Papin's case, fatal issue). One finds that the nature of the pyloric stenosis is often only revealed after completion of the gastro-enterostomy and has then at times led to operation on the gall-bladder as well. Judging from the cases recorded in the literature the prognosis is serious; the technical difficulties of the operation are not infrequently considerable, and the interference most trying to the patient.

In the year 1913 I had for operation (No. 1:446, 1913; a woman, aged sixty-eight) where in addition to cholelithiasis and cholecystitis there was probably also a fistula between the deep, diverticular, strongly protuberant part of the gall-bladder and the duodenum. This, however, could not be definitely ascertained at the operation. At the operation—at which I was assisted by Professor Berg—cholecystectomy and retrocolic posterior gastro-enterostomy was done. In the suspected fistulous area a small part of the wall of the gall-bladder was left *in situ* in close contact with the duodenum; here three lines of suture were laid; first, one line involving only the margins of the diverticular remains, then a second one bringing the duodenum well over the first, and finally a covering with omentum. Recovery followed.

During the years 1917 and 1926, respectively, I had a case where the symptoms of pyloric stenosis were undoubtedly similar to those present in the above-quoted cases from the literature.

The *patient from 1917*, I:729, woman, aged sixty-seven, had on July 14 that year been taken ill with mild pains in the epigastrium. During the period July 19 to 21 she vomited blood repeatedly. Was admitted to the medical clinic on July 21, her general condition being then remarkably little affected. She was very tender on the slightest palpation of the abdomen, somewhat more in the upper part than the lower. The abdomen was slightly distended. The liver (?) could be felt one finger-breadth below the thorax in the nipple-line. Lungs, heart and urine normal. The vomiting continued daily up to July 27 inclusive. No brown discoloration of the vomit. Faecal specimens collected July 24-26, and on July 30 showed negative reaction on testing with Weber. *Röntgenological examination*, July 30: In upright position the opaque meal collects into the lower part of the stomach, the lower pole of which is in the small pelvis, the upper limit being horizontal. At the top of the duodenal bulb there is a gas bubble almost as large as a hazel-nut. Peristaltic waves gradually begin to appear in the fundus, proceeding toward the pylorus with even outlines. The gas bubble still remains on the top of the bulb, even during passage of contents through the descending part. The duodenum never empties completely. In recumbent position the peristalsis is considerably increased. The bulb never gets completely filled, and is distinctly tender on pressure. No defect or persistent depression of the stomach. A high intermediate layer is to be seen in the stomach. In prone position the duodenal bulb seems fairly well filled. Considerable residue after four hours. The gas bubble at the top of the bulb with sedimentation of the contents, the tenderness over it and the marked retention all point in the direction of a probable *ulcus juxta-pyloricum duodeni* (Ström).

Patient was transferred to the surgical clinic on August 1, 1917. There had then been no vomiting since July 27 and the abdomen was neither distended nor tender. Below the costal margin one could feel a firm mass, not tender on pressure and with the surface and lower edge uneven. Test-meal August 2: Quantities of remaining currents, acid reaction, Kongo negative and Uffelmann positive. Never any raised temperature.

*Operation*, August 3 (Troell): Median incision in the epigastrium. Difficulty encountered in exposing the stomach partly owing to the lower edge of the great omentum being adherent in the small pelvis. The pyloric part of the stomach and duodenum the seat of a tumor, larger than a hen's egg, fixed and with difficulty movable. Impossible to determine its point of origin. The pyloric vein cannot be seen. It is covered, as well as adjacent duodenal portions, by firm, vascular adhesions and intimately united to the inferior surface of the liver and to the pancreas. The whole thing gives one the impression of cancer. Some glands as large as beans are seen in the great omentum. A posterior gastro-enterostomy is made in the usual way, somewhat obliquely, without loop and close to the pylorus where the ventricle adapts itself most conveniently to the jejunum. Nausea and vomiting during the three first days after the operation. Healing by first intention.

Test-meal August 17: Current-stones, total acidity 40, Kongo negative.

August 28: Patient who all the time has taken her food badly was to-day taken fairly suddenly ill with malaise. Vomiting supervened that seemed partly to be of faecal nature. There was also coughing with a moderate amount of tenacious sputum. No dulness over the lungs. Behind, especially on the right side, bronchial breathing and here and there fine, dry râles. Pulse very bad despite stimulants. Vomiting less severe toward the evening. The condition became rapidly worse and the patient died in the forenoon of the following day. *Patho-anatomical diagnosis*: Bilateral muco-purulent bronchitis plus bronchopneumonia of the left lower lobe plus cholelithiasis plus abscess after purulent perforating cholecystitis plus subcutaneous abscess in the operation wound



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(Ströman). The post-mortem report describes the changes in the operation area in the following words: In the region of the gall-bladder there is an abscess as large as a lemon, limited in front by a thin wall and behind separated from the kidney and the stomach by a thicker, membranous wall. At the bottom of the abscess cavity there is the thin-walled, torn gall-bladder and a nodular stone the size of a hazel-nut. The pus in the abscess was dark-colored, thin and turbid." The abdomen was in other respects normal, except for post-mortem changes in the liver.

The patient from 1926, I:675, woman, aged sixty-three, fifteen years ago had painful attacks off and on in the right side of the abdomen as well as jaundice. Gall-stone was diagnosed. Patient had not had any such attacks during recent years. In the autumn, 1925, there was a period of vomiting, apparently, however, of slight nature. Patient did not consult any doctor. Soon after Christmas, 1925, patient felt soreness and burning sensations in the epigastrium, and somewhat later (February, 1926) she brought up plenty of water in the mouth. Alternating with this she began to vomit, which symptom has lately become worse. At times vomiting occurred immediately after food, at other times later, and latterly also in the night. She wasted much in the spring, has not been jaundiced and has had no stomach-ache. Patient has sometimes recognized in the vomit food taken one or two days previously. *Condition June 2, 1926:* General state of health little affected. Heart and lungs normal. Abdomen not distended. No peristaltic movements are seen. From the umbilicus a somewhat tender mass, not fully defined, extends upward to the right. The liver not palpable. Blood: Hæmoglobin 90, red corpuscles 4.8 millions, white 12,000. Blood-pressure 125/70. Urine normal. Rectum examination nil. Test-meal: Numerous current-peals and stones on empty stomach, Kongo negative, total acidity 15, Uffelmann negative. *Röntgenological examination, June 7:* Stomach inconsiderably enlarged, of normal shape and well movable. Powerful stenotic peristalsis. The stomach shows everywhere even and soft outlines. No malformation. No palpable mass corresponding to any part of the stomach. No tenderness on pressure. After four hours almost total residue. The duodenal build does not fill up. It is a case of pyloric stenosis probably caused by infiltration of the pyloric wall (tumor ?) (Andrén).

*Operation, June 10 (Troell)* under the diagnosis of cancer of the stomach or possibly inflammatory tumor in connection with disease of the gall-bladder. Median incision in the epigastrium to two centimetres below the umbilicus. There was a remarkable amount of bleeding on incising the abdominal wall (more like that present in inflammatory processes than in cancer). The stomach is easily brought out through the incision wound and is not the seat of any cancer. Its pyloric portion, however, is strongly displaced toward the right and united, like the nearest part of the duodenum, to the altered gall-bladder and adjacent part of the anterior edge of the liver; this is here drawn downward and backward and the whole thing is matted together into a right-sided mass. This is felt to extend deep down as far as one is able to reach; it is impossible to determine whether it is a gall-bladder filled with stones or one having undergone cancerous changes. It seems most likely to be a question of gall-stones with cholecystitis and perforation of the gall-bladder wall downward toward the upper part of the duodenum, and perhaps also perforation of the duodenal wall; stenosis of the duodenum is certainly present. A couple of strong adhesions are divided between two ligatures. The fundus of the small, thick-walled, shrunken gall-bladder is then dissected free from liver and duodenum. One soon comes across a cavity with trabecular walls and pocket-like protuberances, containing numerous gall-stones. This cavity is evidently made up of the small lumen of the gall-bladder with a protuberance of large size directed downward; this has a narrow communication with the duodenal lumen immediately distal to the pylorus. The stones are removed (about one hundred of them as large as from hemp-seeds to twice the size of peas, faceted and with a cut surface consisting of a large black centre and a thin yellow peripheral area). Most of the gall-bladder is cut away. Cysticus and choledochus are not seen. After sufficient free-

ing of the duodenum from the adhesions far out to the right, the perforation in its wall is transversely closed with interrupted catgut, followed by silk sutures. A small Mikulicz's bag is inserted against the sutures and the remains of the gall-bladder; a large-sized Nélaton is also put in against the latter. Finally a posterior gastro-enterostomy is done with a fairly short loop. Before suturing the duodenal wall one discovered on its inner, posterior surface and in its longitudinal direction a papillomatous, tumor-like formation of the mucous membrane, 3 cm. long and  $1\frac{1}{2}$  cm. in height. The most proximal portion of this extends to the ventricular side of the pylorus; the tumor-like formation is removed. Patho-anatomical diagnosis: (a) The polypus from the duodenal wall is a simple mucous membrane polypus with inflammatory changes; in some places transitional, possibly stratified epithelium. (b) Parts of the gall-bladder: Chronic, inflammatory, hypertrophic changes (Professor F. Henschen). June 26: The wound having re-opened with exposure of the colon and other coils of the gut, a few mattress-sutures were put in, including most of the abdominal wall. After that slow healing. On discharge October 14 the patient's general condition was very good with no pains or discomfort after food. Röntgenological examination October 7: Gastro-enterostomy stomach with the gastro-enterostomy opening placed fairly high up on the fundus just above the sinus. The stomach empties partly through this and partly through the pylorus. The bulb is never completely filled up. Fairly satisfactory emptying of the stomach in different positions. There is a small quantity remaining in the stomach after four hours (Westermarck). Stated by letter of January 14, 1927, to be still in excellent condition.

The clinical course in these two cases conforms very nearly with most of the known cases of pyloric stenosis in cholelithiasis published in the literature. The first patient at the time of the operation had been ill for less than a month and did not seem to have had any symptoms up to that time pointing in the direction of gall-stones. The second patient had had attacks of gall-stone colic many years ago with jaundice, but had been quite well during recent years until symptoms commenced—about six months before admission to hospital—for which she now sought help. As in the first patient, these symptoms consisted almost entirely of vomiting which examination proved to be in the nature of retention. The primary indication for operation in both cases was a suspicion of cancer; the addendum to the report of the operation in the second case, "or possibly inflammatory tumor in connection with disease of the gall-bladder," was put down before the operation partly by reason of the earlier history of the patient, partly by her general condition being so relatively little affected. The Röntgen examination showed a high degree of pyloric stenosis as a result of—from what the findings seemed mostly to indicate—a juxtapyloric duodenal ulcer and tumor.

In the first case the operation itself gave no clue as to the nature of the condition. The pyloric part of the stomach and duodenum made up a tumor, larger than a hen's egg and adherent to the liver and pancreas that, on the whole, gave one the impression of cancer. Gastro-enterostomy was performed. After the lapse of three and a half weeks, however, patient became suddenly very ill and died; the immediate cause of death was pneumonia. The post-mortem examination showed the presence of a well-defined abscess, the size of a lemon, situated close to the stomach; the abscess was in direct communication with the gall-bladder by means of a perforation and

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contained a concretion as large as a hazel-nut; there was no perforation to the gut.

In the second case, as in the first, one found at the operation a tumorous mass firmly adherent to the liver, the nature of which it was first difficult to be certain of. It soon became evident, however, that one had to deal with a much changed, shrunken gall-bladder, containing numerous concretions and with the lower wall protuberant in a downwardly direction; this in its turn was found to be closely adherent to the duodenum with the lumen of which there was a narrow, open communication close to the pylorus. The inflammatory changes which had led to marked shrinkage had, through dragging of the pyloric region upward toward the liver and to the right, given rise to pyloric stenosis—a small polypus in the mucous membrane would not seem to have been of any real importance. This was clearly a case most reminding of Tuffier's, Goullioud's, etc.

It is improbable that the ultimate result in my first case would have been favorable had the treatment, beyond the gastro-enterostomy, been directed in some way or another, to the tumor itself. The chance of extirpating this seemed at the operation to be exceedingly slight; the whole thing gave one the impression of being a fixed, inoperable cancer. As an after-thought, however, it may be said that puncture of the tumor might possibly have given such information as to have led, for example, to cholecystostomy and evacuation of the abscess as supplementary measures to the gastro-enterostomy; this might have saved the patient. My handling of the second case was no doubt justified and correct. Similar procedure has previously been employed in two cases by Bircher (recovery) and in two cases by Friedmann and Cotte (both dead).

### SUMMARY

An account of two cases one of which gave, as it seemed, a long since passed history of gall-stones; the second case gave no such history. Vomiting in the nature of retention indicated operation in both cases which was undertaken in the first place because of suspected cancer. In the first case one found a gall-stone and a perforated gall-bladder, now in communication with an abscess, the size of a lemon, located between the liver and the stomach-duodenum; gastro-enterostomy was done but the patient died three and a half weeks later in pneumonia. In the second case numerous gall-stones were found in addition to a small and shrunken gall-bladder which communicated by means of a perforation in a protuberant part of its lower wall with the most proximal part of the small intestine; on account of traction upward and to the right, caused by inflammatory shrinkage, the pyloric region had become stenosed. After removal of the gettable part of the gall-bladder the duodenal wall was sutured and gastro-enterostomy done; patient recovered. While there are cases on record where symptoms of pyloric stenosis in cholelithiasis have been caused by patho-anatomical changes

similar to those occurring in the second of these cases, there seems to be no earlier record in the literature of any similarity to the patho-anatomical findings in the first case.

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# ACUTE PERFORATION OR RUPTURE OF THE GALL-BLADDER\*

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ALTHOUGH acute perforation or rupture of the gall-bladder is not a very common occurrence, it is not so uncommon as is generally supposed. The purpose of this paper is to draw attention to it as a fairly frequent cause of the acute abdomen, as well as to the difficulties of diagnosis and the high mortality. Georg, in 1925, in a study of the literature for the last thirty years found 348 reported cases, with a mortality of 42 per cent.

This study is based on twenty cases of perforation or rupture of the gall-bladder occurring among the last 1000 cases of diseases of the gall-bladder and biliary tract admitted to the surgical wards of the Episcopal Hospital. In most instances the actual perforation was demonstrated at operation, but in a few no attempt was made to locate the perforation, the diagnosis being made on the presence of gall-stones or bile in the walled-off or free peritoneal cavity.

The series falls into two groups: Acute perforation into the free peritoneal cavity; and subacute perforation localized by adhesions. Eight of the series belong to the first group, *i.e.*, acute perforation without any attempt at walling off; and twelve to the second group, *i.e.*, sub-acute perforation well walled off by adhesions or omentum. A few instances of perforation of the gall-bladder into a hollow viscus—chronic perforations—are not included in this study.

*Acute Perforation.*—In the eight cases of this group six were males and two were females, their ages ranging from twelve to sixty-five years; two being under twenty, four between forty and fifty, and two sixty-five years of age. Three of them were suffering from typhoid fever when the perforation took place on the thirty-second, thirty-fourth, and forty-second day of the disease; two recovered and one died; the patients were all males, aged respectively, twelve, twenty-four and forty-two years. Of the eight, four gave a history of previous indigestion and one (the only one in the entire series) was a traumatic case. A brief resumé of the latter may be of interest.

The patient, a female, aged sixty-five years, was admitted to the Episcopal Hospital, service of Dr. Louis H. Mutschler, with a pistol wound of the right side (22 cal. steel-jacketed bullet). At operation, two hours after admission, the findings as reported on the operation sheet were: "Peritoneal cavity full of blood clots and free blood. Perforation of the lower portion of the right lobe of liver one inch from the edge. Bullet had passed through fundus of the gall-bladder, striking and fragmenting a gall-

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stone. Perforation of the ileum, mesentery, transverse colon, etc." In addition to the intestinal repairs a cholecystostomy was done. The patient recovered.

*Diagnosis.*—As already indicated, a correct pre-operative diagnosis of a perforation or rupture of the gall-bladder is not common. In the present series the tentative diagnosis comprised: intestinal (typhoid) perforation, gangrenous cholecystitis, appendiceal peritonitis (one each), perforated duodenal ulcer (three), probable perforation of the gall-bladder (one). In other words, the true lesion was suspected in only 12.5 per cent. of the acute cases.

In the histories of this acute group the outstanding symptom that might lead to a suspicion of gall-bladder trouble was "repeated bilious vomiting"—noted in all but two—the traumatic case and one typhoid case. Some previous digestive trouble is also a common feature, five, *i.e.*, all but the typhoid patients, giving a history of gall-bladder indigestion. Jaundice, on the other hand, does not form part of the syndrome; in fact, it was not present in any of the acute group. The blood count is indicative of severe infection. In the typhoid cases it ranged from 6200 to 24,600, and in the others from 19,800 to 28,000. In the early stage the symptoms are highly suggestive of a perforated duodenal or gastric ulcer, and, as we have seen, that was the most frequent diagnosis in the acute cases. There is the same sudden onset of acute pain, marked abdominal rigidity, together with a previous history of indigestion. A large perforation with flooding of the peritoneal cavity with bile is probably accountable for the cases in the literature that were incorrectly diagnosed as intestinal obstruction or diffuse peritonitis. In the late stage of perforation or rupture, when a diffuse peritonitis has developed, confusion is even more apt to occur, and the most frequent diagnosis then is appendicitis with diffuse peritonitis or perforative peritonitis of unknown origin.

*Duration of Perforation.*—In the acute series the duration of the perforation was from four hours to three days. Of the three typhoid patients, two were operated on within five hours of the first symptoms of perforation, with one recovery and one death, while the third came to operation within twelve hours after perforation and recovered. The traumatic case has already been referred to, and of the four remaining cases two were operated on twenty-four hours after perforation, one recovery; the remaining two were operated on the third day after perforation, both dying. Thus we have a mortality of 50 per cent. (four out of eight cases). The operation consisted of cholecystectomy (two), with one recovery and one death; cholecystostomy (five), three recoveries, two deaths; simple peritoneal drainage (one), death due to peritonitis. Death was due to peritonitis in three and to myocarditis in one of the four fatalities. Stones were present in four of these acute cases, the traumatic and three others.

The bacteriological report on five cases was: Typhoid bacillus, one; bacilli, two; no growth, two.

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*Subacute Perforation.*—The group comprises ten females and two males, twelve in all. The age incidence shows a much higher average than in the acute cases, three being between thirty and forty, two between forty and fifty, two between fifty and sixty, four between sixty and seventy, and one over seventy years of age. Eight of the series gave a previous history of gall-bladder trouble of from two months to several years' duration.

*Diagnosis.*—In this second group it is not so difficult to locate the trouble as in the first one. Vomiting was the clinical symptom common to all, chills were noted twice, while jaundice was present three times, slight in two cases and very deep in the third. In the latter, at operation, a large stone was found impacted in the cystic duct. The white blood count in eight cases ranged from less than 11,000 (three) to more than 20,000 (five). A palpable mass was noted in six (50 per cent.).

Although a clinical diagnosis of perforation or rupture was not made in any of this group, the gall-bladder as the site of the trouble was noted ten times, the diagnosis being calculus or non-calculus cholecystitis; the other two were tentatively labeled high appendiceal abscess. It must be remembered that these subacute cases all came to the hospital several days after the inauguration of the acute onset, and with well-defined and localized symptoms, so that it was comparatively easy to recognize the gall-bladder as the site of the lesion. I believe that if they had been seen in the acute stage many of them would have been listed in a different category. Acute calculus cholecystitis, for example, during the height of the attack may be difficult to differentiate from a perforation. The most common condition producing a mass in the gall-bladder region is a distended, acutely inflamed gall-bladder plastered around with omentum. This is what four of the six cases of this series, with a palpable mass, were thought to be. Besides a high appendiceal abscess, two other conditions, a pericholecystic abscess and a subacute rupture of the gall-bladder, may give a palpable tender mass in this region. The mass of a pericholecystic abscess, however, when palpable, is exquisitely tender and is usually situated higher in the abdomen and nearer the midline than in the other conditions mentioned.

*Duration of Perforation.*—The approximate time elapsing between the symptoms of perforation and admission to the hospital ranged between four days (two cases), seven days (three cases), ten days (two cases), two weeks (three cases), and three weeks (two cases). Operation in this subacute group consisted of cholecystectomy in four cases, with one death; cholecystostomy in eight cases, with two deaths; either procedure thus giving a mortality of 25 per cent. The death after cholecystectomy was due to peritonitis, while following cholecystostomy one death was due to uremia and the other to pulmonary oedema. The bacterial findings in cultures in eight of this group were negative six times and positive for bacilli in two. One of the latter was the fatal case after cholecystectomy. Gall-stones were found in eight and bile only in the other four of this subacute group.

*Etiology.*—The chief etiological factor leading to rupture or perforation of the gall-bladder seems to be ulcerative cholecystitis, usually, but not always associated with the presence of gall-stones. McWilliams, in a collected series of 108 cases of spontaneous perforations of the biliary system, found stones present in 74 per cent., and Fifield found them in twenty-six out of twenty-eight cases reported from the London Hospital. In our series stones were present in 25 per cent. of the acute and in 75 per cent. of the subacute group. According to McWilliams, the mechanism of the perforation may be due to various causes: (1) Rupture from over-stretching, with or without the presence of stones; (2) pressure of a stone upon the wall causing ulceration; (3) gangrene due to (a) thrombosis of the vessels with or without stones; (b) cutting off the circulation due to pressure from a stone; (c) diphtheritic, ulcerative infection of the wall, with or without stone.

Mitman reports a case of chronic pancreatitis and ulcerative cholecystitis in which the gall-bladder ruptured, and attributes the catastrophe to increased abdominal pressure while straining at stool. Torsion of the gall-bladder, together with rupture, was reported to this Academy by Wendell in 1898.

Carcinoma as a cause of rupture of the gall-bladder is very unusual. Although Bonnet reports one case, we failed to find any case in our series in which malignancy was the etiological factor in producing the rupture, although the incidence of carcinoma of the gall-bladder was 1.3 per cent. in the 1000 cases of disease of the gall-bladder and biliary system.

Infection passing through the wall of the gall-bladder and producing a localized pericholecystitis or even a pericholecystic abscess is frequently met with, but it is rare for a diffuse peritonitis to develop in this way. Köerte has reported three such cases, while Richardson, Finsterer and others have observed instances in which bile was found in the free peritoneal cavity, but no perforation was demonstrable.

The cultures taken in both our acute and subacute cases bear out the work of Judd and his associates, and of Rosenow, Brown and others, that the bile does not offer any reliable data as to the presence or absence of infection of the gall-bladder wall and bacterial growth is inhibited by concentrated bile pigment, as shown by the experimental work of Drennan and others.

*Treatment.*—Successful treatment, as in every acute perforation of an abdominal viscus, depends largely upon early diagnosis and early operation. Perforation of the gall-bladder, however, differs from acute perforation of the duodenum, for example, in that it is infective from the beginning. This is well demonstrated in the cases that come to operation within a few hours after onset. Cultures taken from these may show a growth, while it is exceptional to obtain a positive culture from a perforated duodenal ulcer within the first twelve hours.

The question arises whether to do a cholecystostomy or a cholecystectomy.



ideal is to remove the gall-bladder, but as there is no time for study and preparation in these emergency cases, the choice will depend upon the location of the perforation, the age, the general physical condition of the patient, and such laboratory data as can be obtained. Statistics seem to favor cholecystostomy. Our own series is too small to afford any deductions, but mortality was alike, high, for both operations—fifty per cent.

The subacute cases present more time for study of the kidneys, the heart, the cardio-vascular system, and the little we know of the liver function.

In the majority of instances these patients, after they have been fully studied, can be leisurely prepared for operation so that they come to the operating table in much better condition than the acute ones.

If there is a large palpable mass and the incision is made directly into the mass, I believe it is best to establish free drainage and nothing more. If necessary, a cholecystectomy can be done later. But if no mass is palpable, and the perforation is not suspected until the free peritoneal cavity has been opened, the mass having been carefully walled off with gauze packs, if it is found that the adhesions can be easily separated and the ducts exposed without difficulty, a cholecystectomy can be done, but it produces more trauma and opens up new avenues for infection and absorption, so that also the deciding factors must be the laboratory data, the age of the patient and his general resistance, as far as this can be determined.

The obese patient with acute cholecystitis, especially if a female over fifty years of age with marked myocarditis, is the type of case that we know from experience is the more apt to develop acute dilatation of the heart or so-called liver shock. In such instances, therefore, a cholecystostomy, which takes less time and produces less trauma, is the better procedure.

#### CONCLUSIONS

From the foregoing, it appears that the incidence of rupture or perforation of the gall-bladder is about two per cent. of the diseases of the gall-bladder and biliary tract. The reason it is not more frequent can be traced to several factors: The musculo-fibrous coat of the organ is quite dense and resistant, its lymph and blood supply is abundant, and finally the action of sterile bile on any organisms that may invade the gall-bladder wall seems to reduce their virulence.

Although several cases are on record, besides our own case, in which perforation of the gall-bladder resulted from trauma, beyond the fact that such an accident may happen to an organ lying so protected within the abdominal cavity, the chief interest, it seems to me, is the apparently innocuous effect of sterile bile on the peritoneum and the length of time a ruptured gall-bladder may be present without destroying the patient. This is shown by the cases reported by Lane, Gare, Hildebrand, Fifield and others, and should give great comfort to those who routinely close the abdomen in all cases of cholecystitis.

May their patients' bile always be sterile!

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# SACRO-COCCYGEAL CHORDOMA

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TUMORS arising from remnants of the primitive notochord were considered a great rarity only a few years ago. The extensive work done on the embryology of the chorda dorsalis has led more readily to the identification and recognition of these

tumors. Exhaustive reviews were written by Stewart (1922)<sup>12</sup> in England, Coenen (1925)<sup>4</sup> in Germany, Eckel and Jacobs (1925)<sup>5</sup> in the United States and finally by Stewart and Morin (1926).<sup>13</sup> These papers contain a complete bibliography with a thorough and detailed description of clinical, gross anatomical and histological features of these tumors. Although throwing no



FIG. 1.—Low magnification. View of tumor. Smaller and larger islands of tumor cells separated by connective tissue septa of varying thickness; small hemorrhagic areas in the left upper part, necrosis in the right upper portion. (X 60.)

new light on this subject we believe that our case should be added to the constantly increasing number of reports. It is of considerable interest to the pathologist and the frequency of its correct interpretation makes it a clinical problem of great importance.

## REPORT OF CASE

E. M., fifty-six years, white, male, married, salesman, was admitted to the surgical wards of the New York Post-Graduate Hospital on September 24, 1924, referred by one of us (Stewart), suffering of hemorrhoids and also complaining of the presence of a tumor in the sacral region. His father died of pulmonary tuberculosis; no other constitutional disorders were noted in the family. At the age of six he had pneumonia. Since then he has had no serious illness. In 1918, he was operated on for hemorrhoids. The tumor in the sacral region was first noticed one year before admission to the hospital and had slowly enlarged to its present size of a small orange. It at no time was

tender or painful. He had recurrence of his hemorrhoids, which bothered him for the last three months before admission, associated with occasional slight bleeding from the rectum. He wore a truss for a double hernia without discomfort. He denied any venereal infection. Examination showed an elderly, well-developed, well-nourished man. On the left leg varicose veins were found. A tumor mass was noted in the sacro-coccygeal region posteriorly, lying in the midline, of the size of an orange, fairly soft, oblong, movable under the skin, yet attached to the bone beneath, not tender. Rectal examination revealed internal hemorrhoids. A barium-colon enema with gastrointestinal X-ray series before operation was negative. He was operated on September 25, 1924; the tumor and hemorrhoids were removed. The tumor was adherent to the



FIG. 2.—Small islands of tumor cells invading the areolar tissue between the muscle bundles; some of these nests lie in close proximity to the striped musculature. ( $\times 80$ .)

tumor is composed of islands of cells separated by strands of connective tissue of varying thickness. These islands or lobules are of various size; some reaching the diameter of 200 to 250 micra, others again are reduced to a width of 15 to 20 micra. Such smaller cell nests are composed of only three to four cells. The tumor is surrounded by a thick fibrous capsule around the greater part of its periphery. In one area, however, groups of tumor cells can be found in close contact with striped muscle fibres. The connective-tissue trabeculae show a rather mild degree of small round-cell infiltration. The blood-vessels—mostly thin-walled capillaries lined by flat endothelial cells—are dilated and filled with red blood-cells, leucocytes and lymphocytes. They are confined to the septa and do not invade the tumor parenchyma. The latter shows advanced degenerative changes. The cells are sparsely situated, separated by a homogeneous substance giving the mucin-reaction with specific stains. Small areas of necrosis and foci of hemorrhage can be recognized. In other areas, however, the cells are in close proximity to each other, closely set. The individual cells vary in size, shape and staining reaction considerably. There are small oval or rounded cells with finely granular eosinophilic protoplasm and small deeply staining nuclei. Others are larger, contain occasional vacuoles of smaller or larger size; the rest of their protoplasm is strongly eosinophilic; the nuclei are small and irregular. There are cells reaching a diameter of 40 to 45 micra, consisting of a nucleus either centrally located or pushed to the side compressed by one or several vacuoles, resembling a crescent, thereby giving the cells an appearance of a signet ring, such as is encountered in colloid carcinoma.

periosteum with a deep honey-combed attachment; some difficulty was encountered in its removal but it was extirpated completely.

Our notes on the pathological examination of the tumor read as follows:

*Gross.*—The tumor is irregular in shape, soft in consistency, measuring  $9 \times 8 \times 7.5$  cm. To one side of it striated muscle fibres are attached. It is lobulated in structure, composed on section of a very soft translucent grayish-red mucinous tissue. It appears to be encapsulated in part by a fairly firm connective-tissue membrane.

*Microscopic.*—The

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Other huge structures appear to be protoplasmic remnants of such cells; the nucleus has disappeared, apparently as a result of pressure by the contents of the vacuoles. Many authors state that these vacuoles contain glycogen. We could not demonstrate its presence in our specimen. Some areas suggest a heavily vacuolized syncytium. Such physaliphores of varying size are characteristic for this tumor and have been traced to identical elements of the chorda dorsalis. The more compact cell aggregations show greater variation in size and shape of their elements. One observes small, deeply eosinophilic staining cell-structures with disproportionately larger nuclei and curiously mottled chromatin arrangement. Other larger cells with few vacuoles contain two to three nuclei of varying size. No mitotic division figures are found. It may be rather interesting to note that the centre of the tumor shows more advanced mucinous and other degenerative changes, whereas the cellular areas with irregular configurations are more frequent around the periphery of the tumor.

The diagnosis was sacrococcygeal chordoma.

The post-operative course was uneventful, the wound healing by primary union. The patient was discharged on October 4, 1924, in good condition. He was seen on several occasions since his discharge and appeared in excellent shape each time. He was last seen on January 13, 1927, in

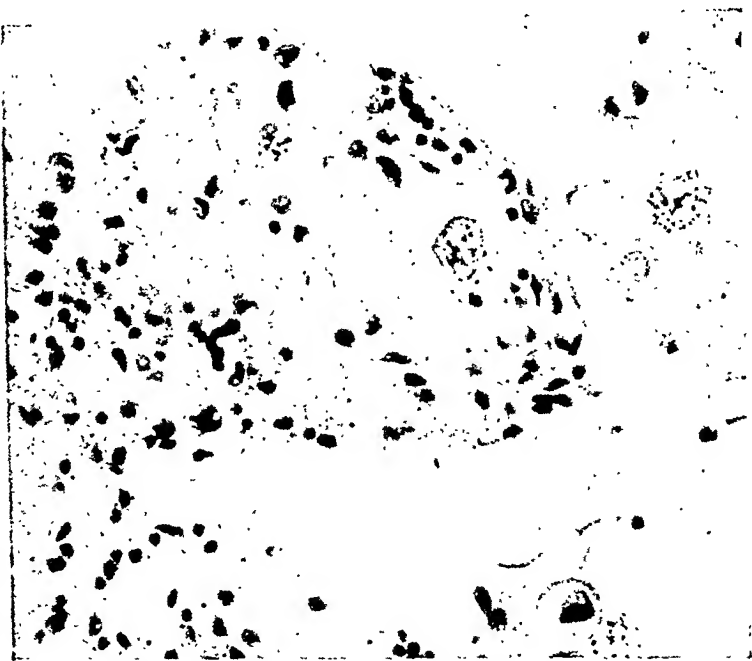


FIG. 3.—High-power photomicrograph. Note the variety of individual cells and their nuclei; a vacuolized cell with a giant nucleus slightly above and to the right of the centre. (X 650.)

good health with no tendency to recurrence. No evidence of local recurrence or metastasis was found at any time. He had four treatments of deep Röntgen-ray therapy; the first application one month after operation; the second application two months after operation; three months elapsed before the third X-ray dose was given; the fourth and final dose was applied one month later.

*Comment.*—Virchow in 1856, described soft, transparent, jelly-like nodules near the clivus Blumenbachii at the spheno-occipital synchondrosis, not exhibiting any active growth or infiltrative properties. He designated them as ecchondrosis physaliphora, prompted by following considerations: the nodules were always situated near the cartilage in a stereotyped relation to the latter; they were of a glassy, jelly-like consistency; they were often associated with an exostosis; finally he interpreted the physaliphorous cells as vacuolized cartilaginous corpuscles.

Müller<sup>8</sup> in 1856, however, wrote: "A direct relation of these growths to the chorda dorsalis cannot be overlooked and I consider them to be excessively growing remnants of the chorda. Whosoever likes the name may designate these masses as chordoid tumors or chordomas."

Müller's opinion could not prevail against the authority of Virchow and it was not until 1894 when Ribbert suggested to Steiner<sup>9</sup> to clear this problem,

that this growth was finally put into its proper place. Steiner proved conclusively that the soft clivus tumors were situated strictly in the midline; no transition from cartilage into the jelly-like mass could be observed, but the cartilage and mucinous tissues were lying next to each other; finally that the physaliphorous cells were remnants of the chorda.

Ribbert demonstrated the derivation of the chordomas from chordal remnants experimentally by puncture of the nucleus pulposus in the centre of the

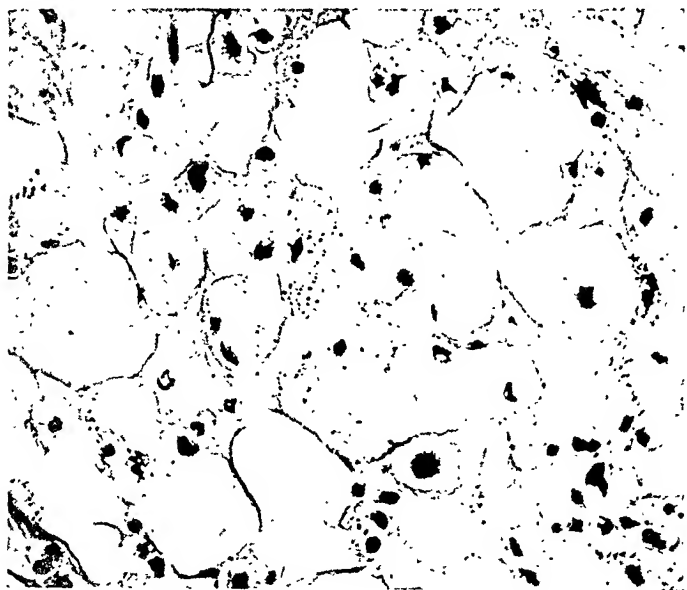


FIG. 4.—Another area. Large vacuolized cells, larger physaliphorous cells, signet ring forms and some syncytial elements, etc. (X 650.)

intervertebral cartilaginous discs, thus producing tumors of identical gross and microscopic appearance.

From a survey of the literature one notices that chordomas were observed in following locations: (1) hypophyseal, (2) nasopharyngeal, (3) maxillary, (4) at the tooth of the epistropheus, (5) vertebral, (6) caudal. The latter ones were found: (a) antesacral, (b) retrosacral, (c) centrally within the bone.

They may be benign, such as described by Virchow and others under the name of ecchondrosis physaliphora, more correctly to be called ecchordosis physaliphora (Stewart). Most of them are malignant. The degree of malignancy varies, however. Many grow very slowly, are locally invasive, infiltrating the surrounding connective tissue or the musculature, sometimes destroying portions of the bone; recurrence is tardy, mostly local. Relatively few cases have been reported of either lymphatic or distant metastasis with rapidly fatal course.

Linck<sup>6</sup> in a thorough study on the development of the chorda dorsalis in the neck and head regions came to the conclusion that one can easily trace the undifferentiated, granular compact, eosinophilic, small vacuolar and larger physaliphorous cells of the chordoma from similar formations in the various stages of the development of the chorda dorsalis. In another paper on malignant sacrococcygeal chordoma to which is added a study of the development of the vertebral and caudal part of the chorda dorsalis, Linck and Warstat<sup>7</sup> state that during embryonal life there can be demonstrated in certain places along the course of the chorda, nests of apparently extruded chorda cells outside of the vertebro-skull basis anlage, which are in direct and close connection with the surrounding soft tissues. They may occur

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dorsally and ventrally in relation to the vertebral column. These remnants may be considered as embryonic inclusions and are an additional support for Cohnheim's theory. Linck and Warstat conclude that chordoma may only occur in and be limited to portions where such persistent chorda cell-complexes occur outside of the axial skeleton. In their last review (January, 1926) Stewart and Morin collected fifty-seven cases. We would like to add the ones reported by Walz,<sup>15</sup> Sommer,<sup>11</sup> Cameron,<sup>3</sup> Argaud and Lestrade<sup>2</sup> since. Doctor Lederer in Brooklyn, New York, showed us sections of his case. This makes a total of sixty-three cases.

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OBTURATOR HERNIA  
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CASE.—J. F., age twenty-four, was admitted to the University of Maryland Hospital, March, 1923, having been referred by Doctor Metzger of the Medical Service. He had been operated upon for bi-lateral inguinal hernia sixteen years previously in York, Pennsylvania. Since that time he had complained of attacks of intermittent severe pain in the lower abdomen.

Examination showed scars from old operation. Abdomen was distended, very tender and painful over lower right quadrant. Rectal examination was negative. A definite diagnosis was not made because the patient was also suffering from illuminating gas poisoning, which occurred after first attack of pain four days previous. A tentative diagnosis was made of ileus, probably due to gas poisoning.

At operation by Dr. Arthur M. Shipley a loop of ileum was found in the right obturator foramen (Strangulated Richter's Hernia). No attempt was made to repair the hernial sac in the foramen because of the poor condition of the patient.

Convalescence was stormy for a few days. Patient was discharged from the hospital in three weeks following operation. Recurrence in two months. In the meantime patient suffered from pain, especially if on his feet much of the time. Pain radiated to his knee (Howship-Romberg Sign).

Second operation May 2, 1923. Right rectus incision. Right obturator foramen would admit the index finger for about three inches in length. The sac was sutured to the parietal peritoneum after pulling the apex of the sac through the foramen. Patient lived three years, apparently cured of the hernia, but died by drowning.

In 1724, Arnaud de Ronsil before the Academy of Surgeons of Paris described the first case of obturator hernia. Duverney also reported a case before this society he had found in the cadaver. Among other early observers have been Garengot, Heuerman and Cloquet. In an article abstracted from the Museum Catalogue of St. George's Hospital, Stanley gives an account in the *Lancet* in 1850. He quotes the following, "Yet we are informed by Garengot that Arnaud had reduced several obturator hernia and kept them up by bandages and he himself had seen and reduced two such cases of ruptures in the living subject, and two other cases had been communicated to the Academy."

Lawrence in his text-book in 1843 declares Garengot's cases were the first proven cases of obturator hernia. Sir Astley Cooper also states in his text-book in 1843 that the only case he had seen was from a preparation in the Museum of St. Thomas' Hospital and unfortunately there was no history of the case. de la Garrenne reported a case in 1726 and Lecroissant reported a case in 1743. According to Erickson in the *Lancet* in 1850 the first case successfully detected and operated on with recovery was by Henry Obre although Hilton had opened the abdomen in 1847 for obturator hernia (*Med. Chir. Trans.*, vol. xxi, p. 326).

In addition to the case reported I have reviewed the literature up to 1909



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## ABSTRACT OF CASES, 1909-1924.

Operator	Age	Sex	Foramen	How.-Rom. Sign	Operation	Result
Wagner, A. ....	72	F	Right	Negative	Laparotomy and femoral incision. Tube and ovary in sac	Cured.
Levit, J.: Case No. 1. ....	37	M	Left	Negative	Laparotomy resection of portion ileum	Death.
Case No. 2. ....	68	F	Left	Negative	Laparotomy recurrence in two months	Cured.
Case No. 3. ....	76	F	Right	Negative	Autopsy	.....
Van Zwalenburg..	88	F	Bilateral	Negative	Laparotomy recurrence in 9 years	Death.
Klopp.....	65	M	Right	Positive	Laparotomy	.....
McMahon.....	50	M	Right	Negative	Laparotomy and femoral incisions	Death
Milligan.....	46	F	Right	Negative	Inguinal incision	Cured.
Stones.....	69	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Richter.....	59	F	Left	Negative	Laparotomy, Richter's hernia	Cured.
Sawday.....	60	F	Right	Negative	Laparotomy, Richter's hernia. Resection	Death.
Davis and Eccles.	60	F	Right	Positive	Laparotomy, Richter's hernia	Death.
Sohn.....	65	F	Left	Positive	Laparotomy and femoral incisions, rt. tube and ovary in sac, side to side anastomosis	Cured.
Gunderman..... Case No. 1. Case No. 2.	72	M	Left	Positive	Inguinal incision. Richter's hernia	Cured.
Franke.....	56	F	Left	Negative	Laparotomy, secondary obstruction due to adhesions	Cured.
Ebnother.....	65	F	Right	Positive	Laparotomy and femoral incisions	Cured.
Plunplun.....	52	F	Right	Positive	Both incisions	Cured.
Koennecke.....	70	F	Right	Negative	Both incisions, resection small gut	Cured.
Kindl.....	54	F	Right	Negative	Laparotomy, resection small gut	Cured.
Zora: Case No. 1. ....	68	F	Left	Positive	Inguinal incision, resection intestine	Cured.
Case No. 2. ....	60	F	Right	Negative	Laparotomy, Richter's hernia, resection gut	Cured.
Goebel.....	60	F	Right	Negative	Femoral incision, Meckel's diverticulum in sac	Death.
Hohmeier, F. .... Case No. 1. Case No. 2.	60	F	Left	Negative	Autopsy	.....
Rud.....	54	F	Right	Negative	Laparotomy. Resection of intestine	Cured.
Gauthier.....	52	F	Right	Negative	Femoral incision	Cured.
H. R. A. ....	51	F	Left	Negative	Laparotomy	Cured.
Richardson.....	61	F	Right	Positive	Both incisions, resection 15 cm. intestine	Cured.
Stirling.....	36	F	Left	Positive	Laparotomy	Cured.
Haines.....	72	F	Right	Negative	Laparotomy	Cured.
Gelpke.....	53	F	Left	Negative	Laparotomy	Cured.
Keppich: Case No. 1. ....	83	M	Left	Negative	Laparotomy	Cured.
Case No. 2. ....	83	F	Bilateral	Negative	Both incisions	Cured.
Rawles.....			Right	Negative	Femoral incision	Unknown.
					Laparotomy, Richter's hernia	Death.

ABSTRACT OF CASES, 1909-1924.—*Continued.*

Operator	Age	Sex	Foramen	How.-Rom. Sign	Operation	Result
Marshall.....	..	M	Left	Positive	No operation	.....
Rischbeith.....	72	F	Right	Negative	Laparotomy, Richter's hernia, also had a femoral and sciatic hernia	Death.
Zinner.....	47	F	Right	Positive	Autopsy, Richter's hernia	Death.
Meyer:						
Case No. 1....	73	F	Bilateral	Negative	Autopsy	Death.
Case No. 2....	52	F	Left	Negative	Both incisions	Death.
Case No. 3....	70	F	Left	Negative	Femoral incision	Death.
Case No. 4....	82	F	Right	Positive	Both incisions, Richter's hernia	Death.
Case No. 5....	56	F	Left	Negative	Both incisions, Richter's hernia	Death.
Case No. 6....	58	F	Left	Positive	Both incisions	Death.
Klaus.....	70	F	Right	Positive	Autopsy	Death.
Kinscherf.....	47	F	Right	Positive	Femoral incision, Richter's hernia	Cured.
Steinneger:						
Case No. 1....	61	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Case No. 2....	..	F	Right	Negative	Both incisions	Cured.
Mourier:						
Case No. 1....	66	F	Right	Negative	Laparotomy	Death.
Case No. 2....	70	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Samarelli.....	52	M	Right	Positive	Femoral incision. Also had inguinal hernia	Cured.
Schoemaker.....	63	M	.....	Positive	Femoral incision, Richter's hernia	Death.
Van der Hoeven..	60	F	Right	Positive	Both incisions	Cured.
Kudlac.....	76	F	Right	Positive	Laparotomy	Cured.

with a detailed study of the cases reported from 1909 to 1924. Various men have reported groups of cases and there seems to be a discrepancy in the number of cases reported to date. The total number of cases on record varies from 250 to 400 according to different authors. From the Surgeons' Catalogue and the Index Medicus I find there has been about two hundred articles written on this subject and I have been able to find only 258 cases reported up to 1924. I believe there has been a repetition of cases in some instances and thereby making the number of cases on record as many as four hundred.

Since obturator hernia is no longer a rarity the mortality is gradually becoming less although it is still a little higher than the mortality of acute intestinal obstruction. If all cases be treated or managed as obstruction cases the mortality would still be less. If more emphasis be given to the Howship-Romberg Sign (pain on inner side of thigh radiating to the knee) and to the fact that a large number of them are Richter's herniæ, more correct diagnosis and naturally a lower mortality would result. Any case presenting the picture of intestinal obstruction with bowel movements would make one suspect an internal strangulation at the site of one of the smaller hernial rings, especially if there is no evidence of previous operation.

Many cases are confused or diagnosed as ileus or strangulated femoral hernia. If the latter can be ruled out then the operative procedure should be

through the abdominal route because we are dealing with an acute obstruction with a very high mortality. A complete operation can only be done by opening the abdomen. These patients are very ill and in many cases enterostomy may be the choice of procedure to get a live patient. Summers and Bonney have shown enterostomy is most effectual if done in the jejunum. This is one of the advantages of the abdominal route over the femoral. If a secondary operation be indicated in certain cases the osteoplastic flap of the pubic bone as described by Schwarzchild may be used.

In making a summary of the statistics in this group of cases, including the case reported herewith I find nine cases to be in the male, forty-five cases in the female and one case the sex is not given.

The age is not given in eight cases. Three cases were found between the ages of eighty and eighty-eight. Eleven cases were found between the ages of seventy and eighty, fourteen cases, between the ages of sixty and seventy, thirteen cases between forty and fifty, two cases between thirty and forty and the case reported was twenty-four years of age, the youngest case of the group.

A positive Howship-Romberg Sign was given in twenty cases, including the case reported, and given as negative in thirty-five cases. Sixteen cases were definitely described at Richter's hernia, two contained the tube and ovary in the sac of the hernia and one contained a Meckel's Diverticulum.

Thirty-three of the herniæ were in the right foramen, seventeen in the left foramen, three bi-lateral and in two cases the foramen was not given.

There were eighteen operative deaths, twenty-nine operative recoveries, five cases found at autopsy, and in three cases the result was not given.

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# ACUTE INFLAMMATION OF DEEP ILIAC LYMPH-NODES

By W. E. COUTTS, M.D.

OF SANTIAGO, CHILE

FROM THE UROLOGICAL CLINIC OF THE UNIVERSITY OF SANTIAGO

Acute inflammation of the deep iliac lymph-nodes is not common. According to a recent monograph of C. Lugones, Assistant Professor of Clinical Surgery in Buenos Aires,<sup>1</sup> who studied three cases in children of nine months, three and nine years of age, respectively, this condition may give rise to clinical symptoms that can lead surgeons to diagnose an acute intraperitoneal process. In all the three cases studied by Lugones, the inflammation was attributed to microbic metastasis following broncho-pulmonary infection.

According to Cunningham,<sup>2</sup> the deep iliac nodes are small but numerous. They lie on the lateral wall of the pelvis in front of the internal iliac artery and the ureter, and in the angle between the internal and external iliac vessels. Their afferents are: (a) the lymphatics which accompany the gluteal and sciatic vessels from the deep parts of the buttock and back of the thigh; (b) the lymphatics from the deep parts of the upper or inner portion of the thigh and the efferents of the obturator gland, and (c) visceral lymphatics from the lower two-thirds of the vagina, the bladder, the seminal vesicles and vas deferens, the prostate, the upper portion of the urethra and from the roof of the penis and clitoris.

In the absence of external wounds, and in view of their anatomical relations, it is easy to explain their inflammation in cases of acute or chronic inflammatory lesions of the rectum, vagina, prostate, seminal vesicles, etc. We have not registered metastatic inflammation of these nodes. In all four of our cases the origin of infection could be traced to inflammatory processes either of the posterior urethra, prostate or rectum. Colon bacilli, or associated strepto- or staphylococci and Koch's tubercle bacillus, have been the determining agents. As surgical treatment has not been attempted, we have not been able to ascertain the true nature of the pathogenic microbes and in mentioning the former bacilli, we have only relied upon the clinical symptoms and findings.

Symptoms usually appear gradually. First a slight painful feeling in the deep part of corresponding iliac fossa, which increases on sneezing, coughing or whilst passing stools. Gradually pain increases; slight or high fever sets in and patient takes to bed or consults a physician. When inflammation is severe, there may be a slight degree of peritoneal reaction, accompanied by hiccough, nausea, etc., and locally by a positive Bloomberg's sign. Dysuria was present in three of our cases. A constant and rather early symptom in all four cases has been the pain experienced at the end of micturition. This feeling may

<sup>1</sup> Lugones, C.: "Acute Adenitis of Deep Iliac Ganglia." *Revista Medica Latino Americana*, page 719, January, 1926, Buenos Aires, Argentine.

<sup>2</sup> Cunningham: "Text Book of Anatomy."

range from a slight vague tenesmus to an excruciating painful sensation which may determine a reflex retention of urine as recorded in one of our cases.<sup>3</sup>

A slight numbness or tingling sensation may be felt along the whole lower extremity. Œdema of the thigh, leg and foot due to compression of deep iliac vessels and nerves may be present.

Compression of ureter may determine transient hydronephrosis or a gradual increase in backward pressure on the kidney accompanied by general symptoms in direct relationship with an increase in blood urea.<sup>4</sup> This influence may be greater in aged patients in whom there always exists a variable degree of nephrosclerosis.

Local inspection reveals rigidity of the corresponding half of the abdominal wall in its inferior quadrant. When nodes are largely inflamed, bulging of the anterior abdominal wall can be recorded in relation to the deep mass. Deep breathing produces a spasmodic contraction of the inferior segment of the corresponding rectus abdominis.

Palpation is of great importance. Complete relaxation of the abdominal wall must be tried. Sometimes inflamed nodes are better felt with the patient in lateral decubitus (affected side uppermost). When the size of the inflamed ganglia is very large, superficial palpation allows us to ascertain the existence of a tense, painful, immovable tumor in intimate relationship with the deep pelvic portion of the iliac bone. If the nodes have not fused and formed a confluent mass, deep palpation is necessary, and when pressing them against the osseous structure of the pelvis, intense pain is produced.

Rectal examination is of great importance. Laterally, to right or left, according to the nodes inflamed, a soft, pasty, painful mass can be felt. A difference in local temperature corresponding to the affected side can be recorded by the exploring finger. Combined bimanual, rectal and abdominal examination, may allow fluctuation to be ascertained if present.

In three out of the four cases that have come under our consideration, cystoscopy was practiced. In all we recorded a falling in of bladder wall toward its lumen and bullous œdema in relation to the part nearest the inflammatory process. Cystograms, in some cases both anterior and lateral, show clearly deformation of bladder shadow owing to its displacement by the neighboring mass.

Comparative diagnosis must be made with other acute processes either of right or left iliac fossæ. We shall only mention the most common, and therefore those which may lead surgeons to error. To the left we have (a). fecaloma, volvulus of iliac portion of rectum, acute spermatitis and strangulated hernia in all its varieties. To the right, the most common source of error may be acute appendicitis in a posterior descending vermiform. Comparative diagnosis with such a condition is very difficult as clinical symptoms are practically the same at onset. In such a case that came under our observation all

<sup>3</sup> Coutts, W. E.: "Acute Deep Iliac Adenitis. A Case Accompanied by Complete Retention of Urine." *Revista de la Sociedad de Urologia*, page 268, April, 1926, No. 9, Santiago, Chile.

<sup>4</sup> Chevassu, M.: "Les uremies curables." *Presse Medicale*, page 329, April, 1923.

the initial symptoms described for deep iliac adenitis were present, even to terminal stranguria. Operation revealed a descending posterior vermiform with adhesions to the bladder wall. It was only intense muscular defense which decided us to operate. Strangulated hernia and acute spermatitis must also be regarded as possible sources of error.

We shall now present the clinical histories of our cases and afterward discuss their treatment.

CASE I.—R. A., male, aged fifty years, enters ward No. 15 (Urological Department) of the Hospital Clinic, March 20, 1926.

*Hereditary Antecedents.*—Father died of tuberculosis; mother of cardio-renal disease.

*Previous Diseases.*—Grippe on various occasions. At the age of ten, amoebic dysentery. Since then he suffers of chronic constipation. He insists on never having acquired venereal diseases.

*Present Illness.*—A fortnight ago whilst working, general lassitude sets in, accompanied by nausea and a feeling of gastric fulness. No stools are passed, but there is abundant emission of gases. This condition lasts for five days, when he takes a saline purge and evacuates stools in large quantities. In the afternoon he discovers the existence of a painful tumor in the right iliac fossa and experiences slight stranguria. Pain at the end of micturition increases, rendering the passage of urine unbearable. Five days ago he suffers a violent retention of urine which makes catheterism necessary. General condition becomes worse; the slightest movement in bed arouses intense pain in the lower abdomen. Under these conditions he enters hospital.

*Physical Examination.*—Facies of intense suffering. Wasting condition is very marked. Skin is dry and pleats are easily made. Tongue dry and furry. Pulse is rapid (120 per minute). Temperature 39.6° C. in the rectum. Nausea and vomiting. Abdominal inspection shows a slight bulging of the anterior abdominal wall in its inferior portion to the right. Palpation reveals intense muscular resistance of lower two-thirds of rectus abdominis, more marked to right. Deep iliac nodes of this side are very large and tender to touch; they form a single mass which extends toward the median line.

Urethra is free in all its length to a No. 18 Mercier catheter. Urine obtained through catheter is somewhat cloudy but only contains very few pus cells. Testicles and vas deferens nothing particular. Rectal examination shows a small well-limited unpainful prostate. Toward right wall of rectum a soft, painful mass can be felt. Heart and lungs nothing of importance. Wassermann's blood test was negative. Owing to reflex troubles of micturition and to avoid patient further suffering, we decided to leave a permanent rubber catheter in the bladder.

During patient's sojourn in hospital, blood urea increases to 1.02 grms. per litre (29 III). On the 6th of April the quantity descended to 0.61 grms. per litre and thence sank gradually down to normal. Owing to high fever and general toxic symptoms we delayed cystoscopy till the 8th of April. Bladder holds easily 200 c.c. of liquid. Mucous surface normal in appearance in superior, inferior and left lateral walls. Right wall falls into bladder lumen and presents patches of bullous oedema. Both ureteral orifices are of normal aspect. After cystoscopy patient evacuates bladder spontaneously. A catheter passed immediately afterward allows us to ascertain the absence of residual liquid. On this same date we take two cystograms, one in anterior and another in the lateral position, using as contrast a 10 per cent. sodium bromide solution. Anterior cystogram shows clearly the displacement of vesical shadow due to neighboring inflamed nodes. Lateral view shows quadrangular shadow of deformed bladder due to compression of extrinsic mass.

Patient gradually recovers and leaves hospital in excellent condition. Three hard insensible masses are felt in relation to inflamed nodes.



## ACUTE INFLAMMATION OF DEEP ILIAC LYMPH-NODES

CASE II.—M. N., male, aged twenty years, enters ward No. 15 (Urological Department) of the Hospital Clinic, August 23, 1925.

*Hereditary and Personal Antecedents.*—No importance.

*Previous Diseases.*—Slight chills occasionally. Two years ago gonorrhœa for the first time. He disregards its treatment and six months afterward develops right epididymo-orchitis.

*Present Illness.*—Once acute inflammation of right testis declined, a small hard tumor remained in the caudæ, which two months later started to grow in size and ultimately opened spontaneously on the postero-inferior region of corresponding bursæ, giving rise to a fistula which persists up to the present.

In March, 1925, left caput epididymis suffers a similar process that broke out on the postero-superior surface of the corresponding bursæ. Simultaneously pollakiuria set in, most marked during the day time.

*Physical Examination.*—Patient of apparent good health. Urine cloudy, containing numerous pus cells. Urethra free in all its length to a normal sized exploring bougie. Slight difficulty in posterior urethra. Scrotum adherent to both epididymi, in intimate relationship with fistulæ which eliminate pus in large quantities. Both epididymi present irregular surfaces, due to existence of numerous painful nodules. Testicles are apparently normal. Vasa deferentia are hard and irregular. Rectal examination reveals an enlarged, uneven prostate containing numerous hard nodules. Liquid obtained after soft massage contains numerous pus cells, Koch bacilli (Ziehl-Neelsen), Gram-negative bacilli and staphylococci. Posterior urethroscopy (MacCarthy's cysto-urethroscope) shows deep tubercular ulcerations of verumontanum and surrounding tissues.

Heart and lungs nothing of importance. Radioscopy was negative as to tubercular lesions. Wassermann's blood test was also negative. Patient is submitted to a general treatment associated with subcutaneous injections of progressive doses of tuberculine, sun baths and iodoform paste locally.

General and local conditions improve rapidly and patient remains in the ward as helping hand.

In the first days of May, 1926, he complains of a troublesome sensation in the left iliac fossa. Dysuria accompanies pollakiuria. Three days afterward he takes to bed, with high fever, nausea and gradually increasing pain in the lower portion of abdomen. Temperature rises to 39° C. Local inspection reveals a soft, painful tumor in the deep portion of pelvis to the left. As symptoms are not well defined, he is placed under observation. Next day both local and general conditions are decidedly worse. The size of tumor has increased and he complains of a tense sensation in the whole of the left lower extremity. Peritoneal reaction is intensely marked. Rectal examination allows us to ascertain the existence of a pasty painful mass, which under bimanual palpation gives the impression of fluctuation. Fever is always high. We diagnose acute inflammation of deep iliac nodes, due probably to a tubercular process associated to pyogenic germs which have reached the nodes through the ulcerations of the posterior urethra. During the next few days the local condition remains *in statu quo*. Left inferior extremity increases its size to double. Arterial beat in the upper portion of Scarpa's triangle cannot be felt. Pachon's oscillometer needle indicates the absence of arterial pressure.

A cystogram, with a 10 per cent. sodium bromide solution in the anterior position, shows displacement of bladder shadow by an extrinsic mass. In a few days more, local and general symptoms subside rapidly. Fever descends and oscillates between 37.2 and 37.6° C. Lower extremity recovers its normal size and arterial beat can be easily felt even in the popliteal space. Arterial pressure is nearly normal.

Ten days afterward cystoscopy still allows us to ascertain a falling in of bladder wall to left and a cystogram shows bladder contour nearly normal, only to the left a

slight depression can be recorded. A fortnight afterward patient has renewed his usual work.

CASE III.—M. C., male, aged twenty-one years. Medical student.

*Former History.*—Of no importance. Never has acquired venereal diseases.

*Present Illness.*—On the 12th of April, 1926, and in absence of sexual intercourse, a slight urethral discharge is observed, accompanied by a slight burning sensation during micturition. Two or three days afterward pain in both thighs and slight swelling of superficial iliac nodes sets in.

In this state I examine him for the first time. Microscopical test of the urethral discharge shows pus cells in abundance and large quantities of micrococci. Urine is clear and contains some large mucous threads. Superficial iliac nodes are enlarged, painful to touch, but fluctuation is absent. Repose in bed and urethral treatment with a suspension of bismuth subnitrate in glycerine. Nodes do not improve under this treatment. He went to his home in Valparaiso. During his sojourn there the adenitis is surgically opened on both sides. Bacteriological examination of pus obtained only revealed the existence of common micrococci catarrhalis.

In a fortnight he returns and starts his medical course once more. A week afterward he suddenly feels a painful sensation in the right iliac fossa and pollakiuria sets in. Fever rises to 38.5° C. He also notices the existence of a deep, hard, painful mass to touch. Rectal examination shows existence of a large hard tumor in intimate contact with the right wall of the rectum. He remains in bed and two days afterward deep nodes to the left start inflaming. In a week's time he gets up and ten days later cystoscopy shows a falling in of both lateral walls of the bladder and a marked congestion of mucous surface to left.

Anterior cystogram with a 10 per cent. sodium bromide solution shows flattening of inferior wall. Lateral cystogram taken with same solution shows deformations of bladder due to squeezing between inflammatory masses.

CASE IV.—N. N., aged twenty-six. Physician.

*Former Diseases.*—In 1925 acute gonorrhœa complicated with left epididymo-orchitis.

*Present Illness.*—During the month of June of the present year he experienced slight trouble in the left iliac fossa which he attributes to his former inflammatory process of that side. Painful sensation is not persistent, but has intimate relationship with sexual intercourse. On July 13, after excessive sexual intercourse, pain starts once again, but of a severer character. On examination, one could easily ascertain the existence of a large, painful, deeply placed mass in the iliac fossa to the left. Marked resistance of abdominal wall and high fever. Rectal examination reveals a soft, unpainful prostate and an inflamed left seminal vesicle. Pollakiuria is intense and urine cloudy in both glasses. In this condition he is examined by other colleagues who diagnose the same condition, acute inflammation of the iliac nodes. After a few days in bed, associated with adequate treatment both of local and general conditions, he returns once more to his practice.

*Treatment.*—Refers to treatment of local and general conditions in relation to determining cause. Rest in bed and ice locally. Quinine, salipirin, etc., to bring down temperature. Saline laxatives to keep bowels free. Slight diet, milk and plenty of stewed fruits. Ichthyol enemas can be placed in the rectum. Where an Arzberger's canule can be procured, hot irrigations through the rectum are very helpful. In all cases we have employed vaccine therapy. Mixed staphylo- and streptococci, associated to colon bacilli vaccines have given best results. During convalescence general tonics are administered. Special attention should be paid to treatment of determining cause.

# COMPLETE RUPTURE OF INFRA-PATELLA TENDON AND ADJACENT CAPSULAR LIGAMENTS

By LEWIS CLARK WAGNER, M.D.

OF NEW YORK, N. Y.

FROM THE THIRD SURGICAL DIVISION OF THE RUPTURED AND CRIPPLED HOSPITAL

A COMPLETE or partial break in the continuity of a muscle or tendon is not a rarity and in reviewing the literature it seems that this condition has been described with appropriate operative procedures or splinting for every important tendon in the human body except the infra-patella tendon. Tears in this tendon associated with fracture of patella or those instances in children in which the patella tendon is pulled from its insertion at the upper end of the tibia are excepted. I can find only one somewhat similar case as reported by Kreuscher.<sup>1</sup> The infra-patella tendon is described in anatomical works as that portion of the ligamentum patella which extends from the lower margin of the patella to its insertion in the anterior tuberosity of the proximal end of the shaft of the tibia. The anterior capsule of the knee-joint is formed by the collateral patella ligaments, which are the expansion of the vasti tendons and fascia lata on the lateral sides of the joint. The ligamentum collaterale fibulare is hidden within a covering derived from the ilio-tibial tract of the fascia lata. The medial expansion from the tendons of Sartorius and the semi-membraneous muscles augment the articular capsule, which then becomes continuous with the ligamentum collaterale tibiale.

The disruption of muscle substance is usually brought about by overstretching, as in lifting or carrying heavy objects, while tendinous breaks are usually associated with added muscular violence upon the already contracted muscular substance. The tear in the tendon most often occurs with the pulling off of its insertion along with its periosteal attachment or its junction to muscle substance, while it may occur through the main part of the tendon but

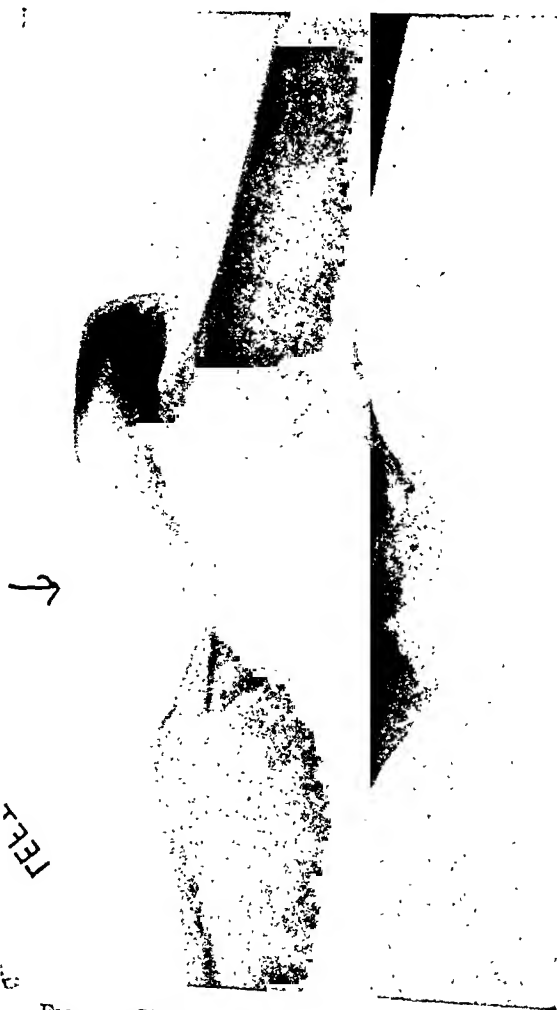


FIG. 1.—Shows patella pulled upward. Separation of patella tendon—V-shaped area of lessened density posterior to region of patella tendon.

one is led to believe that this accident only happens where there is some inherent weakness of the part affected. The break is never complete (Fig. 2)

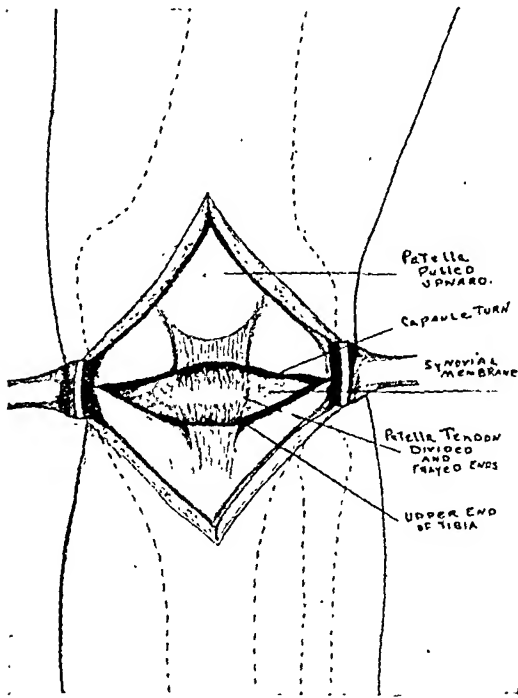


FIG. 2.—Shows tear through capsule and patella tendon with fraying of ends.

as the ends fray out and a few strands of tissue are still holding, although loss of function may be complete. In making the diagnosis one is most apt to notice the loss of function by inability to bring the tendon into action. The patient gives the history of some type of sudden and violent muscular effort. There is sudden pain and swelling, which is soon accompanied by subcutaneous hemorrhage with discoloration. A distinct gap can be felt in the tendon if subcutaneous. There is a shortening and contraction of the affected muscle and elevation of the patella (Figs. 1 and 2) as in the case of rupture of the infra patella tendon. The effusion into the joint is rapid and the finger through the unbroken

skin can palpate the interior of the joint. X-ray (Fig. 1) shows the V-shaped area of decreased density posterior to the patella tendon, which clearly demonstrated the divided tissues and completes the diagnosis.

*Treatment.*—It is well agreed that tears or separations of the smaller tendons only require splinting and rest, as pointed out by Stiell,<sup>2</sup> but an early operation is urged in the rupture of all the important tendons of the body to be sure of absolute restoration of function. The operation (Fig. 3) should consist of accurate approximation of the ends in order to restore normal muscle tone and can be held together by any sort of suture material that will not be absorbed before twenty days. The living suture material is not indicated except in large defects or when the ends cannot possibly be approximated. The limb is completely immobilized for at least forty days until

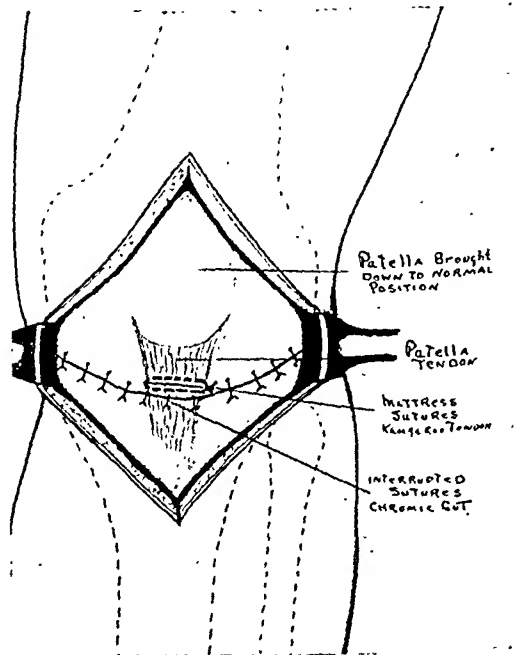


FIG. 3.—Repair completed and patella pulled down.

## COMPLETE RUPTURE OF INFRA-PATELLA TENDON

repair is absolutely certain, after which physiotherapy is instituted. The return to function is then rapid.

CASE REPORT.—Mr. G. S. P. K., age forty, has been very active all his life. On March 1, 1926, he slipped on a rug and in attempting to save himself from a fall, suddenly felt something snap in the left knee and fell to the floor. He was unable to rise because of the pain and inability to extend the left knee. He was seen two hours later. There was no pain except on attempting to move the left knee. Extension was lost. There was marked intra-articular and subcutaneous effusion. The patella was elevated and a distinct gap was noticed in the patella-tendon and the separation extended well around the lateral and internal condyles of the femur. The inside of the joint could be easily palpated, although the skin was intact. A diagnosis of rupture of the patella tendon with capsular tear was made and this was augmented by X-ray. (Fig. 1.) A tight bandage and posterior splint applied to stop the hemorrhage and the joint was put at rest. The knee-joint was explored the following morning and the tendon with the extensive capsule tear repaired. (Fig. 3.) The interior of the joint was normal. The leg was encased in plaster, which was worn for six weeks, at which time active motion and massage were started. The return to function was extremely rapid and at the end of four months patient was discharged cured with normal function and both knees measuring the same.

### LITERATURE

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# TRANSACTIONS OF THE PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held May 2, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

## EXPERIMENTAL SURGERY OF THE ŒSOPHAGUS

DR. GEORGE L. CARRINGTON, of Durham, N. C., by invitation, read a paper with the above title, for which see vol. lxxxvi, page 505.

The author said that the object of his work was first to get satisfactory anastomosis and then substitution. Mobilization of the stomach, pulling it up into the chest and resuturing it to the diaphragm is what the speaker has had in mind. Considerable care is required in the suture to the diaphragm or else hernia may occur and the dog die, if not promptly of dilatation of the stomach; then certainly a few weeks or months later. The mechanical part of such an operation can be handled, but the thing that worries one is the question of infection. Other surgeons interested in the chest have encountered the same difficulties. Some have had the experience of losing all the dogs operated upon and others feel that they can open the chest with impunity. Two workers, whom he has consulted, have had adverse experiences. One thought that dogs that came through without infection had had distemper and recovered, and those that died had not had distemper. Another had come to the conclusion that the pleura was very susceptible to infection. If the question of biological or chemical immunization can be worked out satisfactorily, the surgeon can then feel safe in performing many chest operations now seldom attempted.

## PERFORATION OF THE GALL-BLADDER

DR. EMORY G. ALEXANDER read a paper with the above title, for which see page 765.

DR. JOHN H. JOPSON recalled that this subject was discussed before the Academy in 1913. At that time, several cases were reported. He himself had had two cases of acute perforation into the peritoneal cavity. In looking up the literature, the latest statistics at that time showed 50 per cent. mortality, which is about the same as at present. This winter he had a third case with certain interesting features—among others, the vomiting of blood. Doctor Jopson had been impressed with the fact that the cases seen of rupture into the free peritoneal cavity are cases in which the danger symptoms have been disregarded too long, not only by the physician but often by the patient, and it is a wonder that, treating gall-bladder cases as we do, the accident does not take place more often. Of course most surgeons hope

## CHRONIC INTRACRANIAL HEMORRHAGE

to be able to tide the patient over the attack of acute cholecystitis until the acute symptoms subside. This is the speaker's practice. In a case outside the hospital or even in the hospital, he tells the consultant or resident that the continuance of intense pain will mean operation, even if the time does not seem suitable, because in his experience these are the cases which perforate. For example, the case this winter was that of an elderly man, who had had repeated attacks of gall-bladder disease. He was seen after he had been ill for a week and a diagnosis of probable empyema of the gall-bladder was made, pointing out to his physician that a recurrence of severe pain might indicate perforation. The following morning the patient vomited blood and was more or less collapsed. Operation was performed on the same day while in a desperate condition. The gall-bladder had perforated into the peritoneal cavity and a large number of small stones were found in the subhepatic space. These were scooped out as thoroughly as possible. A cholecystostomy was performed and subhepatic drains inserted. For a long while stones were washed out of the drainage tube. He finally recovered. The condition is akin to perforated duodenal ulcer as an emergency and in his opinion much more serious. The speaker expressed surprise that there were not more cases of the encapsulated type of perforation in the Episcopal Hospital series, as he had thought that they were more common than Doctor Alexander reported. There, cholecystectomy is usually the operation of choice.

DR. A. P. C. ASHHURST said that since the meeting to which Doctor Jopson refers, Dr. J. J. Buchanan, of Pittsburgh, before a meeting of the American Surgical Association, stated that he thought cases of biliary peritonitis without visible perforations were due to retroperitoneal perforations, and the bile trickled out through some aperture not seen at the operation. The fact remains that in a number of these cases, the surgeon declares he has seen bile "sweat" out of the gall-bladder. This bile can be wiped off. One condition which may be mistaken for a pericholecystic abscess is passive congestion of the liver from heart disease, and this should be borne in mind. The speaker was fooled once. The patient was a very fat woman, desperately ill, and with a tender mass in the gall-bladder region. The presence of cardiac decompensation was recognized but it was thought she was forming a pericholecystic abscess. Operation revealed a large blue liver. It was then realized that she had congestion of the liver from her heart lesion, and she died from the latter condition three days later. Another time, a patient was sent to Doctor Ashhurst by her physician with a diagnosis of gall-bladder disease. He thought she had only passive congestion of the liver and did not operate, this patient got well.

## CHRONIC INTRACRANIAL HEMORRHAGE

DR. FRANCIS C. GRANT read a paper with the above title, for which see vol. lxxxvi, page 485.

DR. J. S. RODMAN said that generalized subdural hemorrhage is more

common than localized but localized hemorrhage is notorious for its difficulty of diagnosis. Persistent irritating phenomena following trivial injury is at least suggestive of localized hemorrhage. The mortality is high and the speaker regards Doctor Grant's estimate of 25 per cent. as too conservative, believing that 45 per cent. is more nearly the average.

VITAL FACTORS IN THE MANAGEMENT OF PROSTATIC OBSTRUCTION

DR. B. A. THOMAS read a paper with the above title, for which see vol. lxxxvi, page 563.

TREATMENT OF BURNS

DR. WALTER ESTELL LEE and DR. WILLIAM MCCLENNAHAN (by invitation) showed a film of motion pictures illustrating the progress of a severe burn case. The film followed the case from the admission to the hospital, through the various stages of the treatment and finally to the autopsy at which a "Curling's Ulcer" of the duodenum was demonstrated.



# TRANSACTIONS

## OF THE

### NEW YORK SURGICAL SOCIETY

*Stated Meeting Held May 11, 1927*

The Vice-president, DR. FRANK S. MATHERS, in the Chair

#### RUPTURE OF SPLEEN AND DIAPHRAGM. HERNIA OF STOMACH

DR. CHARLES E. FARR presented a boy twelve years of age, who entered the New York Hospital, Service of Dr. Charles L. Gibson, First Surgical or Cornell Division, April 19, 1927, with the history that he had been knocked down and run over by a taxicab immediately before admission. He was not unconscious but had pain and considerable shock.

Examination showed a slight bruise over the left costal margin and similar bruises over the pubis. None of these were conspicuous nor of any size. On admission pulse was 101. Temperature, 98.2. Blood pressure, 110/70.

There was some tenderness and slight rigidity of abdomen. He vomited once. He was kept under observation for ten hours and given a glucose infusion. His condition seemed fairly good, although the blood-pressure remained low. He was definitely anæmic, as if he were losing blood.

Just before operation, patient showed a curious dullness in the left thorax in the axillary line with a tympanitic area below that and dullness in the left hypochondrium, X-ray was taken and a fluoroscopic examination was made. These showed a large bubble of gas in the left side apparently below the diaphragm, and the diagnosis was made of ruptured viscus, probably the stomach, with free gas in the peritoneal cavity. Unfortunately, in the pressure of work, the X-ray film was not carefully examined, as the correct diagnosis would have been easily revealed.

Operation was performed about eight hours after the injury under ether anaesthesia. A left split rectus incision aided by a transverse incision to the left gave ample exposure. The abdomen was found to contain a very large amount of free blood, both clotted and fluid, and the spleen was lacerated along its inner and posterior margins and was apparently still bleeding freely. At this time it was first noticed that the stomach was not in the field of operation. By traction on the colon the stomach was brought down and a pronounced whish of air announced a rent in the diaphragm. The child's condition at this time was desperate. It was deemed essential to remove the spleen. A pack was inserted across the opening in the diaphragm and the spleen removed with but moderate difficulty. There were many adhesions to the diaphragm, which made delivery of the spleen somewhat tedious.

Examination of the rent in the diaphragm showed a clean cut tear 10 centimetres in length extending from the œsophageal opening toward the left. At each attempt to repair this opening, the child became extremely cyanosed, ceased to breathe, and the pulse became almost imperceptible. With fingers inserted in the opening, the gush of air allowed restoration of equilibrium in the thorax and the child's condition improved. It seemed impossible to repair the damage with any degree of safety. A Gibson-Mikulicz tampon was inserted between the stomach and the diaphragm and a rapid closing of the abdominal wall carried out. The child rallied well, received one transfusion, and has made an uninterrupted recovery, although he ran a slight temperature for several weeks after the operation.

## NEW YORK SURGICAL SOCIETY

The post-operative blood counts have been complicated by the resultant irritation of the wound and a mild pleuritis, apparently aseptic. This, with the splenectomy, gave the following counts:

Date	R. C.	Hemo. Per cent.	W. C.	Poly. Per cent.	Lymph. Per cent.
4/19	3,952,000		18,000	86	14
4/19			31,200	92	8
4/20	3,984,000	75	19,300	80	20
4/21	4,368,000	80	20,700	76	24
4/22	3,452,000		15,000	79	21
4/23		70			
4/25	4,200,000	84	16,200	82	18

Post-operative X-ray examination apparently showed the stomach still retained in the abdomen and a large air bubble in the thorax where the stomach had been. Later examination, however, with the introduction of a little barium mixture, showed that the stomach had become almost entirely a thoracic organ.

The child seems in no distress and certainly is not in condition to withstand an operation for repair of the rent in the diaphragm at present, as his pulmonary capacity must be greatly diminished. There is always some danger of volvulus of the displaced stomach.

This is the only case of lacerated spleen, ruptured diaphragm and herniated stomach that the reporter had been able to find in the literature. In the May number of *Surgery, Gynecology and Obstetrics*, there is a report of a similar injury to a boy nine years of age with a lacerated diaphragm and hernia of the stomach, spleen and colon. This was diagnosed previous to the operation and was cured by a trans-thoracic operation.

### SUPPURATIVE ARTHRITIS OF KNEE

CASE I.—DR. CHARLES E. FARR presented a girl, six years of age, who was admitted to St. Mary's Free Hospital for Children, February 14, 1921, suffering from a stiff and swollen knee, the result of a fall down stairs six weeks before. She was able to walk about. The swelling on the sides had subsided but "came to a point" in front. It had been opened by the family physician and considerable pus evacuated, apparently from the bursa. The family and past history were negative.

Examination showed a somewhat anæmic girl with large tonsils. There were no other findings except the surgical condition. The right knee was swollen, entirely in front of and apparently superficial to the patella. Small drainage wound; skin cyanosed. Function of knee impeded by swelling, but not to any great degree. Temperature 100°. Pulse 104. There was a sub-fibrile temperature for five weeks and then it shot up to 104° and became septic in type, remaining so for four weeks. Von Pirquet test positive.

Operation, March 2, 1921, for better drainage showed no necrosis of patella, possibly tuberculosis. X-ray suggested tuberculosis.

Microscopical examination showed only granulation tissue in abscess wall. A second specimen showed chronic inflammation.

Cultures from throat, nose, ear, yielded streptococci. Culture from knee, staphylococcus aureus.

The knee became stiff but there was no complete bony ankylosis.

She was re-admitted November 5, 1922, and remained until October 18, 1923. A resection of the knee was performed for deformity and pain, as the knee was nearly completely stiff in a flexed position. At operation, the cartilage was badly eroded but there was no evidence of tuberculosis.

## SUPPURATIVE ARTHRITIS OF KNEE

Microscopical examination of the bone and cartilage removed showed a suppurative arthritis, not tubercular. The child was lost sight of after leaving the hospital and was re-admitted February 16, 1927, with a marked varus deformity and apparently bony ankylosis. An attempt was made to correct the deformity by osteotomy of the tibia but when a little force was used the joint opened again leaving a large gap between the tibia and the femur. After a few weeks' rest in plaster, the operative wound was re-opened and a bone graft taken from the middle of the tibia. The original osteotomy wound of the tibia was separated freely and the bone graft driven in transversely. This forced the internal tuberosity of the tibia into contact with the femur. Primary union occurred. The bone has consolidated and the knee is now fairly straight. It is being kept in plaster until firm ankylosis occurs.

It is probable in this case that a further varus deformity will occur if the internal condyle of the femur does not grow in correspondence with the external.

When the child attains her full growth it will probably be necessary to do another osteotomy and insert another bone graft. In this way the length of the leg is somewhat increased, but, of course, not up to the length of the left leg. It may be possible in later years to do an arthroplasty and obtain a movable joint.

This case is shown to illustrate the destructive effect of a septic arthritis in which the Willm's treatment could not be applied.

CASE II.—DOCTOR FARR also presented a case of suppurative arthritis in a woman, forty years of age, who entered the New York Hospital, Service of Doctor Gibson, May 31, 1926, suffering from a perinephritic abscess of staphylococcus origin. She was operated upon for this and made an excellent recovery. During the convalescence she developed a phlebitis in the left femoral vein. This was followed by a typical suppurative arthritis of the left knee, presumably metastatic. About the third day after the first observation of swelling and pain in the knee, aspiration revealed thick pus containing the staphylococcus aureus. Under ether narcosis two long lateral incisions were made into the knee-joint evacuating a large amount of thick yellow pus. No drains and no sutures were used. A light moist dressing was applied and the Willm's method of treatment instituted immediately. The woman was very coöperative and made steady progress in spite of her perinephritic wound. The joint healed in about three weeks and the skin wounds within two months. She is presented as having made a complete recovery from a very severe suppurative arthritis. Motions are normal. There is no creaking in the joint, no pain, and she can walk as well as ever.

An interesting feature in this case is that she is the fourth member of the family to suffer from a severe grade of staphylococcus aureus general sepsis, three of her children having had osteomyelitis; one of them also had a suppurative arthritis of the knee and made a complete recovery.

The Willm's treatment for suppurative arthritis of the knee yields perfect results if it is instituted early and carried out effectively. It will not give such results where actual destruction of joint cartilage has occurred, nor will it give such results where it is impossible to institute early active motion.

CASE III.—DOCTOR FARR also presented a man thirty-two years of age who was admitted to the New York Hospital, July 9, 1926, complaining of painful and swollen joints of twenty-four hours' duration. On the day of admission, the pain in the right knee became very acute. The left ankle was also very tender. On examination, the right knee was very swollen, very painful on motion, and tender to touch. During the day, the swelling increased rapidly and became more painful. The pain was increased by motion. The family

and past history was negative. The patient had had his tonsils removed several years before. He had had no rheumatism and no joint troubles. There was no history of cardiac, digestive, urinary, nor venereal disease.

Physical examination revealed a slightly coated tongue, teeth in fairly good condition, tonsils large, congested and cryptic. There were a few scattered acne pustules. There were no enlarged lymph-nodes. The external genitals were normal. The right knee contained a moderate amount of fluid. There was a definite patella click. Tenderness and swelling were moderate. The left ankle-joint seemed tender but not swollen. Two days after admission, the left ankle had cleared up. The right knee was considerably swollen, and aspiration revealed purulent fluid. Two days later, he was transferred to the surgical division, service of Doctor Gibson, and the point was freely opened by two artero-lateral incisions, each three inches in length. A large amount of yellow fluid escaped under pressure. No drains inserted. We had not been able to carry out Willm's method, although conscientious efforts were made in that direction.

Convalescence was uninterrupted. The wounds healed by granulation. He was discharged on the nineteenth day, with the wounds partly granulated. He had attained a range of about 35 degrees of motion on discharge from the hospital.

Two days later, he was re-admitted because of increased swelling and rise in temperature, evidently due to too early closure of the incisions. The wounds were re-opened under anæsthesia, many adhesions being found. Following operation, the drainage gradually ceased and active motion was continually urged. On the third post-operative day he could walk well on the leg with full extension and 110 degrees of flexion. He has made excellent progress since and he has been able to follow his usual occupation.

This case is presented as one in which too early closure of the joint wounds occurred, but even with this setback, the result is very satisfactory.

Repeated cultures from the knee gave no growth. The nature of the infection remains unknown.

Examination at the present time shows perfect function and no signs of synovitis.

### CARCINOMA OF RECTUM

DR. CHARLES E. FARR presented a woman, thirty-one years of age, who entered the New York Hospital, complaining of loss of weight, strength, pain in the lower abdomen, constipation and blood in the stools. She had lost thirty pounds.

Examination showed a vigorous woman in excellent general health but evidently suffering greatly from the toxemia accompanying cancer of the rectum. This was about four inches from the anal margin and involving the uterus, which was still movable in the pelvis.

March 12, 1926, under local infiltration of the abdominal wall and sacral anæsthesia, the combined operation was performed through the left rectus incision.

The mass, although extensive, was removable, and there were no apparent metastases. A permanent colostomy was established in the left loin. The lower segment of sigmoid was freed down to the rectum and dropped into the pelvis. Through a perineal incision, including also a vaginal extension, the entire anal region, rectum, sigmoid, and uterus were removed *en masse*. This growth was near the limit of operability.

The woman made an excellent recovery after a transfusion. There was little or no infection. She returned home in about three weeks and has been in

## CARCINOMA OF BREAST

excellent health since. She had four deep X-ray treatments at various times since the operation. There has been a leak of urine into the vagina of greater or lesser degree for long periods. This has completely dried up, and then from over-exertion or neglect to empty the bladder, the sinus re-opens. She has gained thirty-five pounds and seems perfectly well. The artificial anus has a very marked tendency to cicatricial contraction and has to be dilated occasionally.

The microscopic report was ulcerating adeno-carcinoma.

## CARCINOMA OF BREAST

CASE I.—DR. HUGH AUCHINCLOSS presented a woman, age forty-nine years, who entered the Presbyterian Hospital in December, 1917, because of a lump in the upper part of her right breast. There was also very definite retraction of the skin over it. Small nodes were palpable in both axillæ. There were small areas of induration in various portions of the left breast none of which were manifestly suspicious of cancer. X-rays of her chest and bones were negative.

A very wide skin excision and extensive fascial dissection was done removing both pectorals, axillary contents, the vascular anastomoses between the intercostal and subscapular branches, and skin grafting the uncovered chest wall with Thiersch grafts. Thirteen days later she returned home.

The pathological report was carcinoma. Attention was called to many mitoses present and to the markedly involved axillary lymph-nodes.

Five months later the left breast was removed because some of the areas of induration had changed so that it was impossible to be sure that the disease had not extended to that side. The muscles and axilla were not dissected. No evidence of cancer was found, however, only the lesions of a chronic cystic disease. She was given radiotherapy by X-ray for a short time after operation but none in recent years.

Beyond occasional times when apical signs suggestive of pleural tuberculosis have been noted, this woman, who showed extensive axillary metastases and a rather large primary tumor, has remained apparently quite well over a period of nearly ten years.

CASE II.—A. F., married, entered the Presbyterian Hospital in March, 1916, because six months previously she had found a lump she described as the size of an olive in the lower outer quadrant of her right breast. She felt well and had lost no weight. A firm lump, situated about half way between the skin and the chest wall, measured a little over an inch in diameter, was noticeably freely moveable, seemed spherical, suggesting encapsulation, and lay beneath skin that moved freely over it. It couldn't be seen and no retraction sign was demonstrable standing, lying down, or on lateral inclination. But on bending far forward, with arm outstretched, and pectoral muscle taut, it was possible to detect the faintest, yet definite, flattening of the breast contour. One node in the axilla felt unusually firm and was considered clinically suspicious. There were no evidences of chronic cystic disease elsewhere in either breast.

A thoraco-mammary incision with excision from posterior aspect of a sector-shaped area, including the mass, was done. It was, grossly, and by frozen section, carcinoma. A wide skin excision fascial dissection, with pectoral muscles, axillary contents, and rectus sheath removal was done, and the wound skin grafted. Subsequent examination of the tissues showed the axillary lymph-nodes contained metastases. She went home thirteen days later. It is now about eleven years since operation and she is apparently quite well.

Operations of a less radical nature may prove adequate in cases where the disease has remained local. When the disease has begun its march through the adjacent lymphatics the most radical procedure possible would seem indicated. No one can tell when this spread has begun or how far it may have gone in any case. Just what the factors may be that are associated with follow up results of long duration aren't known, but very radical removal may be, and not unlikely is, one of them. These two cases demonstrate that cases with axillary metastases well established may remain well for a long period of time after a wide, radical removal. It is difficult to believe that operation did not play some part in their remaining well, and if they had had no operation it is hard to believe they would be alive to-day. Yet, many still contend that people with cancer of the breast are doomed and are just as well off without operation.

#### LATE RESULTS OF OPERATION FOR CARCINOMA OF BREAST

DR. WILLIAM CRAWFORD WHITE read a paper with the above title for which see page 695.

DR. JAMES I. RUSSELL considered that there was a distinct advance in the work done by the group at Roosevelt; they have taken up the work of Greenough and, quite independently, have conscientiously worked over these cases, a number of which he had been privileged to see and on some he had operated. Although it was a splendid thing to see these cases that had remained well for ten years, he did not believe it was yet known what time to say a case is cured. He had seen one case come back twenty-five years after operation with a local recurrence in the skin and she eventually died, thirty years after operation, of pleural metastasis. To the speaker's mind, carcinoma, irrespective of how wide the dissection or how careful the operation, has a doubtful outcome. It acts differently in different individuals; some look quite malignant under the microscope and yet it is extraordinary how long they will go without recurrence. The age incident has its influence; the older they are the better chance they have of dying of something else.

DR. HUGH AUCHINCLOSS said that the most radical operation possible is plausible because of the principle that underlies it. Operation is being done to remove cancerous growth spreading in all directions and the surgeon should then and there take the opportunity to do as much removal as the individual can stand, and should choose those paths that are the ones along which this disease travels preëminently. In regard to the skin incision recommended by Handley the speaker could not agree with Handley's recommendation in this respect.

The vascular routes, blood and lymphatic to and from the internal mammary vessels and nodes lies very close to the skin surface. There are plentiful communications between these vessels and those in the breast tissues. Indeed metastases in the region of the perforating vessels close to the sternum often are apparent in the intercostal spaces so that the routes from the breast to these glands cannot be cut with safety. Undermining close to the skin as

## LATE RESULTS OF OPERATION FOR CARCINOMA OF BREAST

Handley recommends is most desirable, but the nearer one approaches the nipple zone the nearer are these vessels to the skin. Accordingly, as wide skin removal as possible followed by undermining close to the skin, offers a safeguard, the more conservative operation does not.

Doctor Halsted felt very strongly on the subject of skin removal and so expressed himself in a personal conversation Doctor Auchincloss had had with him the last year of his life in Baltimore.

The rectus sheath removal is another semi-theoretical thing. One hardly dares not remove it at the present time. The speaker had never seen carcinoma in the rectus sheath until this year. It was a case in a young woman of chronic cystic disease with extensive papillary proliferation into the cysts in which the breast tissue had been removed but the nipple left in because there had been no evidence of carcinoma on careful microscopical examination. Several months later, however, a lump appeared in the areolar region that, on excision, was found to be carcinoma. Many months afterward the patient had an area of carcinoma in the chest wall. Because she seemed so well in other respects and on the chance that it was a local manifestation this was removed with three ribs and their cartilage and about three-fourths the width of the sternum corresponding. It was found that the growth had involved the pleura, which was then excised so that the pericardium and mediastinum lay bare. Just before she went home, however, another metastasis was found in the chest wall. It had extended to the posterior surface of the pericardium to the lung and over the pleural surface of the left leaf of the diaphragm. It was taken off the pericardium and the lung and from the accessible part of the diaphragm. On cutting across the rectus muscle, however, a cord-like strand of carcinomatous tissue ran through the sheath and into the rectus muscle. That is the only case in which the speaker has ever seen carcinoma in the rectus sheath.

About the technic of removing a specimen for frozen section: It is difficult to tell what to do. One has to employ different methods in different cases. There are cases where the lump is close to the skin and one thinks it is carcinoma but is not sure; in such a case it may be well to make the smallest amount of trauma and cut directly into the growth.

In other cases where there is a broader and deeper area of induration it may be wiser to wholly excise the area and make a search through all parts of it.

There is a definite group where though one lump may be under suspicion, there may be several other lumps in other parts of the breast. The lump under suspicion may be excised and extensive papillary proliferation into the ducts found. This diffuse, papillary proliferation into the ducts must always be regarded with concern, especially when the papillary in growths are lined by cuboidal cells with scant cytoplasm and not the high, pale, so-called "Blasse Epithelzellen" of chronic cystic mastitis. Removal of the breast and search for carcinoma is the safer procedure in such cases.

The lump under suspicion may not be the lump that contains the carcinoma



in some cases. In one case, after removal of the suspected lump which was found to be made up of these dilated ducts filled with cuboidal cells forming papillary processes, the breast was removed. Two centimetres away from the sector-shaped area that had already been removed was a small carcinoma that none of the physicians who had seen the case had noticed at all, and in one node in the pectoral group of the axillary nodes was a metastasis. A third operation was then begun under the same anæsthesia and a widespread radical removal done.

One cannot depend too much on statistics in breast carcinoma, for there are no statistics where are included all the varying factors that go to make statistics tell the whole truth available. The lessons to be learned from statistical tables are by no means always the true lessons. The striking things that occur in two or three cases may teach one more than a host of statistics, no matter how conscientiously compiled.

DOCTOR WHITE, closing the discussion, said that all of the cases who died were considered to have died of carcinoma, and even at the ages of seventy-nine and eighty-two were reported to be carcinoma deaths. He had given the results of the moderate operation practiced by many surgeons as against the radical procedure done by others. He felt that the latter should present similar statistics in order to prove that it is worth while to subject the patient to more severe procedures. The claim that they have no skin recurrence with the radical operation is very interesting and Doctor White wondered how could be explained a case that had recurrence of the skin after sixteen years and died of pulmonary metastasis the following year. Doctor White was sorry that no one spoke of the X-ray therapy as he would like to know if anyone has definite information as to its value in relation to operation. As to removal of the pectoralis minor, the speaker had not seen enough cases in which this had been done to know the results. Doctor Peck, however, had felt that this prevented contracture in the axilla and had advocated it very strongly, for that reason.

#### EDITORIAL ADDRESS

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## OBSERVATIONS IN THE USE OF CISTERNA MAGNA ESTIMATIONS IN NEUROSURGERY

By WILLIAM SHARPE, M.D.

AND

CARL A. PETERSON, M.D.

OF NEW YORK, N. Y.

FROM THE DEPARTMENT OF NEUROSURGERY, NEW YORK POLYCLINIC HOSPITAL AND POST-GRADUATE MEDICAL SCHOOL

WITHIN recent years, a marked advance has been made in the diagnosis and accurate localization of gross surgical lesions of the brain and spinal cord. Many intracranial tumors, which formerly could at most be only suspected from the neurological signs elicited before the exploratory operation, are now being accurately localized by the ventricular aerograms as first described and developed by Dandy, and similarly, a large percentage of surgical lesions of a character to block the free flow of cerebrospinal fluid within the spinal arachnoid are now being differentiated with a greater degree of certainty by the combined pressure registration of lumbar and cisterna magna punctures, as first suggested by Ayer. The following observations have resulted from the utilization of both of these methods of diagnosis, with the further development of the cisterna magna estimation as a means not only of facilitating in selected cases the accurate localization of surgical lesions of the spinal cord but of the cerebral cortex itself.

The injection of air into the posterior horn of one or of both lateral ventricles by means of a blunt ventricular needle inserted through the cerebral cortex and then the use of röntgenograms to outline the ventricles in their various planes, make possible the accurate localization of many tumors dislocating, malforming or impinging upon and indenting the normal outline of the lateral and third ventricles; this information is of particular value in large frontal, temporosphenoidal and occipital tumors—the more silent areas of the cerebral hemispheres as compared with the parietal lobes, lesions of which are more easily disclosed by the usual neurological signs; ventricular aerograms in this clinic have seldom aided the diagnosis of anterior mid-brain tumors and only occasionally of the subtentorial lesions when there is more or less complete obstruction of the ventricles. This method of diagnosis is thus limited to tumors that alter the normal ventricular shape and position and they are usually of the large subcortical type and therefore malignant. During the past twelve years in this clinic, 81 per cent. of all intracranial tumors in adults have been malignant, and if the dural (endotheliomata) and auditory nerve tumors (neuro-fibromata) are excluded, then the

true brain tumor of cortical or subcortical type (excluding the tuberculomata) is malignant in over 94 per cent. of the cases.\*

Tumors of the spinal cord have been of less frequent malignancy—41 per cent. in this clinic; besides, there are other surgical spinal lesions of benign character which may obstruct the normal flow of cerebrospinal fluid in the spinal arachnoid theca, such as adhesions due to a former spinal meningitis or to a fracture-dislocation of the spinal column or to the kyphosis of a chronic tuberculous process, and each of these conditions, but especially that of tumor, may at times require all possible information regarding the lesion in order that the appropriate treatment be instituted at an early date; the nega-

tive value of the combined cistern-lumbar puncture estimations may also exclude a surgical lesion in favor of the vascular type of lesions, such as thrombosis, etc., and thus an exploratory laminectomy be avoided. Only too frequently in the past, an exploratory laminectomy has been performed with negative findings.



FIG. 1.—Case 962. J. B. Supracortical aerogram in a case of suspected meningeal tumor indenting the cortex of the left frontal lobe. The air was injected by the cisterna magna route with the patient lying upon the right side. The normal distribution of the air in the subarachnoid spaces of the sulci immediately excludes a supracortical lesion.

the puncture of the cisterna magna with the slow injection of air to replace the withdrawn cerebrospinal fluid may be of great value in selected cases of suspected cerebral cortical lesions. In a case of suspected dural endothelioma over the left frontal area, 15 c.c. of air were injected slowly into the cisterna magna with the patient lying upon the right side; röntgenograms, with the patient still upon the right side, revealed the injected air in the subarachnoid spaces over the entire left cerebral hemisphere and in such a regular manner throughout the sulci that such a lesion compressing or obliterating the subarachnoid spaces could be excluded with a fair degree of certainty; thus, if a dural tumor or a supracortical lesion had been projecting into and indenting the cortex of this hemisphere, or if a chronic process had obliterated an area of the subarachnoid space, as may occur in cortical tumor and abscess formations, old localized meningitis or

Beside the value of combined cistern-lumbar puncture estimations in suspected spinal lesions,

\* The term "malignant" is here used in the sense that the tumor recurs even after an apparent total extirpation; cerebral gliomata, therefore, are malignant, although they do not form metastases.

old subarachnoid hemorrhage with its fibrous tissue residue, adhesions, etc., then it would have been possible for this area to have been outlined by the röntgenograms since no air could have entered the subarachnoid spaces at the site of the lesion. To ascertain whether the changing of the body and head position of this patient from the right side to the left might cause the air to seek the higher level of the subarachnoid spaces over the right cerebral hemisphere, several röntgenograms were again taken later and it was interesting to note that the air was now found diffused evenly over the right cerebral cortex; in this manner, a possible cortical and supracortical lesion of the right hemisphere was excluded and it is possible that such a lesion could have been demonstrated by the method.

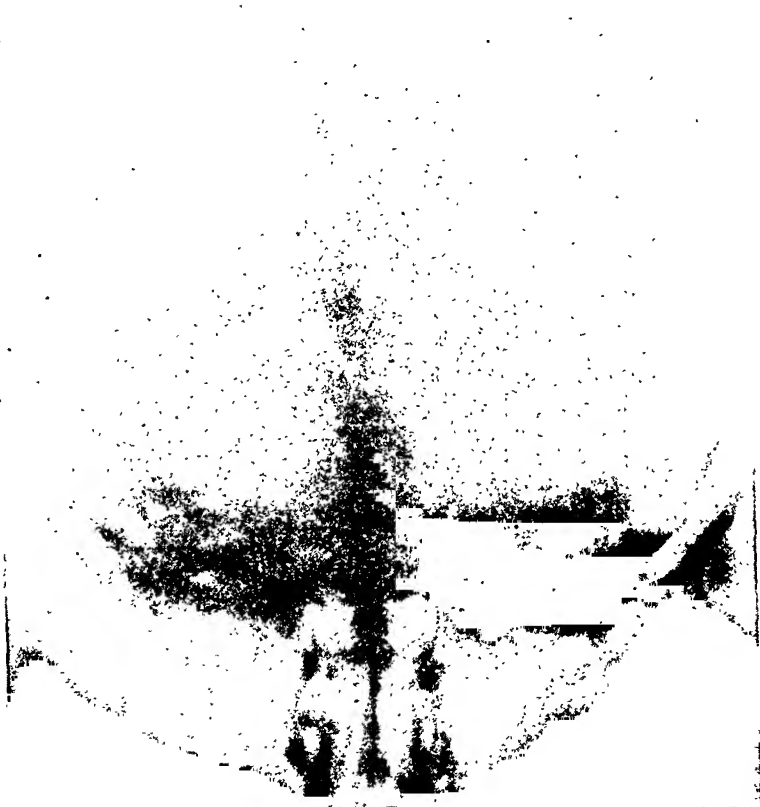


FIG. 2.—Case 1102. A. R. Ventricular aerogram in a case of combined internal and external hydrocephalus, due to a partial blockage of the excretion of the cerebrospinal fluid by unabsorbed basilar and supracortical hemorrhage occurring at the time of birth. The air was injected by the cisterna magna route with the patient in a sitting position and the moderately dilated lateral ventricles are clearly delineated.

hydrocephalus in whom it was important to ascertain the amount of ventricular dilatation and therefore permanent damage, before considering the advisability of an operative method of cranial drainage; ordinarily, a ventricular estimation would have been made for this purpose, but in the hope that the cerebral puncture could be avoided, the less damaging route of the cisterna magna was attempted with the patient in the sitting posture and the head flexed acutely forward so that the chin rested upon the chest. After the injection of the air the patient maintained the upright position until the röntgenograms had been made. As indicated by the accompanying plate, it will be observed that the air did ascend into the fourth ventricle up into the third ventricle and into the lateral ventricles and

a marked dilatation of the lateral ventricles is beautifully depicted; in this manner, the necessary information of the ventricular dilatation was obtained and yet the added damage of a cerebral puncture through the cortex into the ventricle was avoided. This is indeed a marked advance and should always be attempted in selected cases first, rather than advising a ventricular puncture other than as a last resort. Ventricular estimations and röntgenograms as a diagnostic test have had a mortality of almost 10 per cent. in many clinics including this one and there is a distinct danger to life in its use in the presence of large surgically removable lesions; in those cases where no surgically removable lesion exists, naturally the danger to life of the test itself is slight, but there is a definite danger of permanent damage to these patients—not from the standpoint of motor or sensory impairments, but rather from that of emotional and personality changes, increased cortical irritability even to the degree of later convulsive seizures, persistent headaches, dizzy spells, etc.; to insert a blunt puncture needle through brain tissue in patients in the absence of a surgically removable lesion certainly does not improve their condition and such cerebral trauma cannot help but make the condition of the patient worse. Therefore it does seem that ventricular punctures should only be advised as a last resort for patients in whom a surgically removable lesion is most probable and when all other methods of diagnosis have failed to localize the lesion. Naturally in cases of cortical irritability and of epilepsy without an increased intracranial pressure and in possible meningeal processes, no ventricular punctures are to be considered.

Quincke, in 1890, first advocated lumbar puncture as the best clinical method of obtaining spinal fluid for examination; he considered cistern puncture a possible, but unsafe method for clinical use. Both methods had been used by investigators on laboratory animals, but in each instance it was necessary to expose the dura by incising the soft overlying fascial and muscular layers before puncture was attempted. Due to the bony anatomy in the lumbar region of these experimental animals, it was also necessary to perform a laminectomy, whereas the exposure of the dura in the suboccipital region did not necessitate laminectomy due to the absence of spinal processes. At this site, a large area of dura over the cisterna medullo-cerebellaris was exposed by simple flexion of the head after incision of the overlying skin, fascia and muscle. Cistern puncture, therefore, on the experimental animal was considered preferable to lumbar puncture.

In considering the clinical application of these laboratory methods, direct puncture of the cauda equinal theca in the lumbar region was the more rational procedure. The proximity of the vital medullary centres to the exploring needle in cistern puncture condemned this method for clinical use.

It was not until 1919 that Dr. J. P. Ayer, of Boston, with associates in the Army Neurological Service, first presented a paper advocating the use of cistern puncture in the treatment of meningococcic meningitis. In the course of the treatment of this condition by the injection of antimeningo-

coccic serum following lumbar puncture, it had been found, and in some cases even after repeated lumbar punctures, that it was impossible to withdraw a sufficient quantity of spinal fluid to be replaced by the serum; thus in a patient where 30 to 40 c.c. of fluid had previously been readily withdrawn, it was found that but a small quantity, 5 or 10 c.c. of fluid, could be obtained at later puncture. The clinical course of the illness, temperature, headache and cervical rigidity demanded continued serum therapy. The failure of lumbar puncture to drain sufficient spinal fluid was attributed to meningitic adhesions of the spinal theca above the lumbar region. A method of entering the cerebrospinal subarachnoid space at a higher level was therefore sought.

This stimulated further investigation, particularly in reference to the direct puncture of the cisterna medullo-cerebellaris. The direct puncture was first attempted on the cadaver and was followed by careful dissection to learn the relationship of the exploring needle to the neighboring anatomy, particularly the medullary centres. It was found that after extreme flexion of the head, that is with the chin resting on the chest, that the occipito-atlantoid ligament, which extends from the rim of the foramen magnum to a corresponding attachment on the axis or second cervical vertebra, was stretched to a degree exposing adequate space for the puncture of the underlying dura. The depth of the cistern in this location represented the distance from the dura to the posterior surface of the upper cervical cord and the medulla. It was found to be not less than  $1\frac{1}{2}$  cm. in the adult.

The technic of the direct puncture was developed with these observations in mind, and is as follows: The patient is placed on the left side with a thin pillow under the head so as to maintain a horizontal alignment of the cervical spine with the dorsal spine. With head flexed on the chest, and maintained so by the operator's left hand, the thumb of which is placed on the external occipital protuberance and gradually slipped downward toward the first cervical vertebra where a soft depression is felt, the site of the puncture is located. This represents the interspace between the foramen magnum and the first cervical vertebra. With the thumb marking this site, the needle is introduced into the soft part in the midline with the right hand on a plane of a line drawn between the external auditory meatus and the glabella. At a distance of from 4 to  $5\frac{1}{2}$  cm., a resistance caused by the occipito-atlantoid ligament is encountered. Slight pressure and sudden release of this resistance indicates that the needle has entered the cistern and removal of the stylet from the needle should permit the appearance of spinal fluid.

Doctor Ayer has reported over 2000 cistern punctures in which this technic has been used. In this series there were no deaths directly or indirectly attributable to cistern puncture, and he concluded that cistern puncture, by an experienced operator, is a safe procedure. One death has been reported by a German investigator in a series of 310 cistern punctures. A necropsy in this case revealed an abnormally placed cerebellar artery as the cause of death.

The contra-indications of cistern puncture are chiefly any conditions associated with a marked increase of the intracranial pressure to the degree of measurable papilloedema and "choked disc", or in conditions where one may suspect pathology that obliterates the cisterna, as by adhesions of tuberculous meningitis or of extreme internal hydrocephalus.

The indications for cistern puncture in their order of importance have been: (a) The treatment of meningococcic meningitis in the presence of spinal block due to adhesions; (b) the treatment of cerebrospinal syphilis and particularly of general paresis; (c) the early diagnosis of compression of the spinal cord; (d) to obtain spinal fluid when lumbar puncture has been

unsuccessful or in the presence of spinal arthritic pathology; (e) for purposes of irrigation of the spinal canal in suppurative meningitis when combined with lumbar puncture.

The cistern puncture was first used in this clinic as an aid to the early diagnosis of spinal block due to spinal cord tumors as advocated by Ayer in 1920, but it has also been employed to determine its value as a diagnostic method in other neurosurgical conditions. During the first three years, cistern punctures have been used for the injection of air into the basal cisterna by



FIG. 3.—No. 879. I. S. Ventricular aerograms obtained by the injection of air by the cisterna magna route in the case of a suspected subcortical tumor associated with a cortical irritability to the degree of producing convulsive seizures. The advisability of not increasing the existing cortical irritability by the ventricular punctures of the cortical route is self-evident and especially in the presence of a non-surgical lesion. The ventricles are normal in size, shape and position.

gradually replacing the cerebrospinal fluid; röntgenograms, after this procedure, demonstrated that the air assumed the following distribution: it usually was found in the supracortical subarachnoid spaces, particularly in the sulci; occasionally, however, the air passed directly into the ventricles and aerograms resembling those obtained by ventricular air injection were obtained.

Lipiodol, a heavy iodine and olive oil preparation, which shows a shadow with X-ray and was first advocated by Sicard and then by DeMartel, of Paris, as a substance which could be safely introduced into the spinal theca, was next injected by cistern puncture. This substance has been used in the localization of spinal block, as in cord tumors, by assuming a level at

the point of obstruction, which can then be shown by the X-ray. When injected by lumbar puncture, it is necessary to place the patient for an indefinite period, one hour or more, in the uncomfortable head-down position following the introduction of the lipiodol, whereas when injected by cistern puncture, it is only necessary that the patient sit in a comfortable position while the lipiodol sinks to the upper level of the spinal block. Cistern puncture was thus found preferable to lumbar puncture in this investigation. The injected lipiodol, however, was *not* a non-irritant in three cases at least, as Sicard and DeMartel both had affirmed and it has been necessary to discontinue the use of lipiodol in this clinic.†

The combined cistern-lumbar puncture has been employed in the demonstration of spinal arachnoid block and has been found of value. In this procedure, cistern and lumbar punctures are performed at the same time; pressure readings are taken at both levels and should, in the absence of obstruction, be the same. The withdrawal of fluid from the lumbar area should, in the absence of



FIG. 4.—Lateral view of same patient showing the right lateral ventricle of normal size, shape and position. The third ventricle is just visible.

block, result in a corresponding fall in pressure at both lumbar and cistern levels; so also should the withdrawal of fluid from the cistern result in a proportionate lowering of the pressure at both levels. It has been observed that in complete blockage of the spinal theca, the spinal fluid distal to the lesion may only amount to 10 or 15 c.c., and that after this has been withdrawn further drainage is impossible. The Queckenstedt test in combined cistern and lumbar puncture becomes a valuable diagnostic method: upon compression of both jugular veins, there is normally a corresponding rise in pressure at both cistern and lumbar levels. In the presence of spinal block, a rise in pressure is apparent only at the cistern level and slightly, if any, at the lumbar area, depending upon the extent of the block. During the past three years in this clinic, thirty-six cistern punctures have been attempted upon both infants and adults, the age varying from sixteen months in the youngest patient to forty-five years in the oldest. There have been two unsuccessful attempts at cistern puncture:

† ANNALS OF SURGERY, January, 1926, pp. 32-41.

the first occurred in an infant with internal hydrocephalus (the type of case that should not be attempted), and as orientation was difficult, due to the distorted anatomy in the suboccipital region, only one attempt of puncture was made; at later operation of suboccipital exploration, however, it was found that the cisterna magna had been obliterated by the medulla and cerebellum—both having been forced down into the foramen magnum to the level of the second cervical vertebra. The second failure of cistern puncture occurred in a man of forty-five years of age, with a short thick neck; repeated punctures were unsuccessful and for fear of complications, a failure was recorded. At later operation, an extensive sarcoma of the upper cervical vertebræ was demonstrated.

Cistern puncture in this series has been found a safe procedure; the occasional difficulties of lumbar puncture are rarely observed. In this regard, some investigators have considered cistern puncture preferable to lumbar puncture.

In the serum treatment of cerebrospinal infections, particularly meningococcic meningitis and cerebrospinal syphilis, cistern puncture affords a ready approach to the cortical subarachnoid spaces and to the ventricles as demonstrated by the observation of air injected into the basal cisternal and subarachnoid system. Combined cistern-lumbar punctures are a valuable method for the early diagnosis of spinal arachnoid block, though no definite information is obtained as to the level of the blockage. The use of lipiodol injected into the spinal subarachnoid theca in order to facilitate the localization of the blockage is to be avoided for fear of its becoming an irritant, as it is non-absorbable and thus the seriousness of the condition of the patient is greatly increased; ordinarily, lesions in the spinal canal can be diagnosed early and accurately located by the usual neurological examinations and especially by carefully repeated sensory tests aided by the combined cistern-lumbar punctures, without the necessity of recourse to the injection into the spinal canal of substances such as lipiodol, which may produce complications by not becoming absorbed; it has not been possible in this clinic to remove all of it at later operation, as its numerous globules had become encysted at different levels of the spinal theca—chiefly in the caudal sac, but also above and below the level of the spinal lesion.

*Impressions.*—The experience of this surgical clinic in the use of cisterna magna estimations has been a satisfactory one in lesions of the spinal cord—using the combined cistern-lumbar puncture method to ascertain a partial or complete blockage of the spinal subarachnoid space and even of the spinal canal itself by observing any changes in the pressure and the oscillatory wave; the use of lipiodol has been most discouraging, but the injection of air has been most helpful, not only in lesions of the spinal cord, but particularly of the lesions affecting the cerebral cortex, such as meningeal and cortical tumors—supracortical hemorrhagic cysts and the organization-residue



of former localized meningitis and unabsorbed supracortical hemorrhage occurring at birth or at later cranial injury; the demonstration of combined internal and external hydrocephalus and then, of the greatest value, the demonstration of supracortical adhesions and cortical cysts at the site of a former cerebral injury in cases of Jacksonian epilepsy with and without operation at the time of the acute lesion and in those cases of attempted cranial drainage operations when the intracranial pressure was not lowered—the cause very often being due to blockage of the escape of the cerebrospinal fluid through the dural opening by a mass of supracortical adhesions.

There has been no mortality nor any damage whatsoever in the use of cisterna magna estimations in this series of thirty-six patients in this clinic.

# NEUROGENIC SARCOMA

A CLINICAL AND PATHOLOGICAL STUDY

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THE subcutaneous and intermuscular tissues of the arm, leg, popliteal space and chest wall are the favorite seats of a tumor process commonly designated as fibrosarcoma, spindle-cell sarcoma or fascial sarcoma. Based upon the belief that the great majority of these tumors are of neurogenic origin, Ewing has described them under the term of *neurogenic sarcoma*. Because of their comparative rarity the general surgeon does not encounter them with sufficient frequency to be familiar with their true nature. Their innocent appearance and accessibility to removal provide an inviting setting for a simple excision. The serious nature of these small movable subcutaneous tumors is generally not recognized, they are regarded as benign fibromas and are excised, usually under local anæsthesia. The result is a prompt local recurrence followed by repeated excisions and recurrences. The disease becomes progressively more extensive and soon reaches a stage when it is beyond either surgery or radiation and frequently results in death from pulmonary metastasis. The serious nature of cancer of the breast is now sufficiently recognized so that a narrow local excision is usually avoided and the disease is treated by radiation and radical surgery, whereas the small neurogenic tumor with many of the potentialities of a carcinoma of the breast is usually excised with a narrow margin and the recurrences treated in the same manner.

A review of the literature fails to reveal reports of any extensive series of cases observed over a sufficient period to permit deductions as to the best method of approach in the treatment of this disease. In 1922, Regaud,<sup>2</sup> J. Roux-Berger *et al.*, reported nine cases of fibrosarcoma treated in the Radium Institute of Paris. Three were treated by X-rays alone, four by radium alone, and two by a combination of the two agents. None of the patients were cured. They conclude that most of the tumors are radio-resistant, regress slowly and are sterilized with difficulty. Those tumors which are most radiosensitive develop visceral metastasis. They state that from every point of view the operative tumors should be treated preferably by surgery, and believe that radiotherapy is indicated only in the inoperable tumors and as a post-operative measure. Küttner<sup>3</sup> advises wide excision of all tumors which are amenable to radical removal and reports 30 per cent. cured by this method. Seyerlin and Holzel<sup>4</sup> conclude that surgery followed by post-operative radiation is the method of choice in the treatment of these tumors.

There are several important features about this group of tumors which would lead one to expect a favorable prognosis in this disease. In the first place, although some of the more cellular tumors exhibit a high grade of malignancy, many of them grow slowly, and remain localized for a long time. Secondly, their superficial location, permitting early recognition and wide removal without the necessity of sacrificing vital structures, should render this one of the curable neoplastic diseases. In spite of these favorable factors, the final results have not been satisfactory. On the other hand, a small but definite group of cured cases encourages the belief that a detailed analysis of the entire series may reveal important factors which have contributed to the successes or failures, and permit deductions which may prove of value in pointing the direction in the future treatment of the disease. It is the purpose of this paper to present the problem from a clinical and pathological viewpoint, to discuss the clinical course, diagnosis and treatment of this disease based upon a study of seventy-five cases of neurogenic sarcoma treated in the Memorial Hospital in the last fifteen years.

*Pathology.*—Neurogenic sarcomas arise in all situations where connective tissue is found. The rate of growth varies with the structure. At first circumscribed, these tumors soon tend to infiltrate surrounding tissues and sometimes infiltrate and penetrate the walls of blood-vessels, producing metastases. Ewing and many others are of the opinion that the great majority of fibromas and fibrosarcomas of the skin and subcutaneous tissues are of neurogenic origin and designate them as neurofibromas and neurofibrosarcomas. Ewing gives the following classification of fibrous tumors of the nerve trunks:

1. Cutaneous neurofibroma. Fibroma molluscum, Recklinghausen's disease.
2. Neurofibroma of the subcutaneous and deeper nerve trunks. (a) Plexiform neurofibroma. (b) Visceral neurofibroma. (c) Neurofibrosarcoma (neurogenic sarcoma).

*Neurofibrosarcoma.*—In this group the subcutaneous and deeper nerve trunks give rise to tumors which are more cellular than the cutaneous fibromas. They occur at first as slowly growing, circumscribed, firm, movable masses lying in the subcutaneous tissues. The structure varies from benign neurofibroma to highly cellular malignant tumors with markedly atypical cell qualities and invasion of blood-vessels. With an increasing cellular composition and atypical qualities of the cells and a diminution in the matrix, the tumors are more active in their growth, and show a tendency to rapid recurrence and widespread metastasis. Between the two extremes are all transitions in malignancy depending upon the relative cellular and fibrous content of the tumors. Histologically, the cells frequently show an elongated and spindle form and are arranged in intertwining bundles. The very cellular growths appear as large polyhedral cells with little stroma. Giant cells may be a prominent feature, and myxomatous changes are frequently seen. Although typical structures are readily identified, the distinction between benign and malignant neurogenic tumors is at times difficult. Many fibrous compara-

tively cellular tumors are malignant and will recur after surgical removal. Ewing states that when the bulk of cells greatly exceeds the matrix the tumors are usually of active growth and recur.

*Histological Classification.*—Because of the marked variation in the structure of these tumors and the corresponding variation in the degree of malignancy, it seemed convenient to devise some plan of histological classification based upon their relative cellular and fibrous content. Whereas it is fully

recognized that no sharp line of demarcation can be drawn, microscopic examination of a large number of these tumors reveals that they are divisible into several groups. A distinct relationship between histological structure and clinical course metastasis and final result has been demonstrated in this way.

*Myxosarcoma.*—The structure of fascial myxosarcoma presents distinctive microscopic features which differ from those found in neurogenic sarcoma and permits a differentiation between these tumors histologically. The only cells recognizable in fascial myxosarcoma are those concerned in the formation of capillaries,

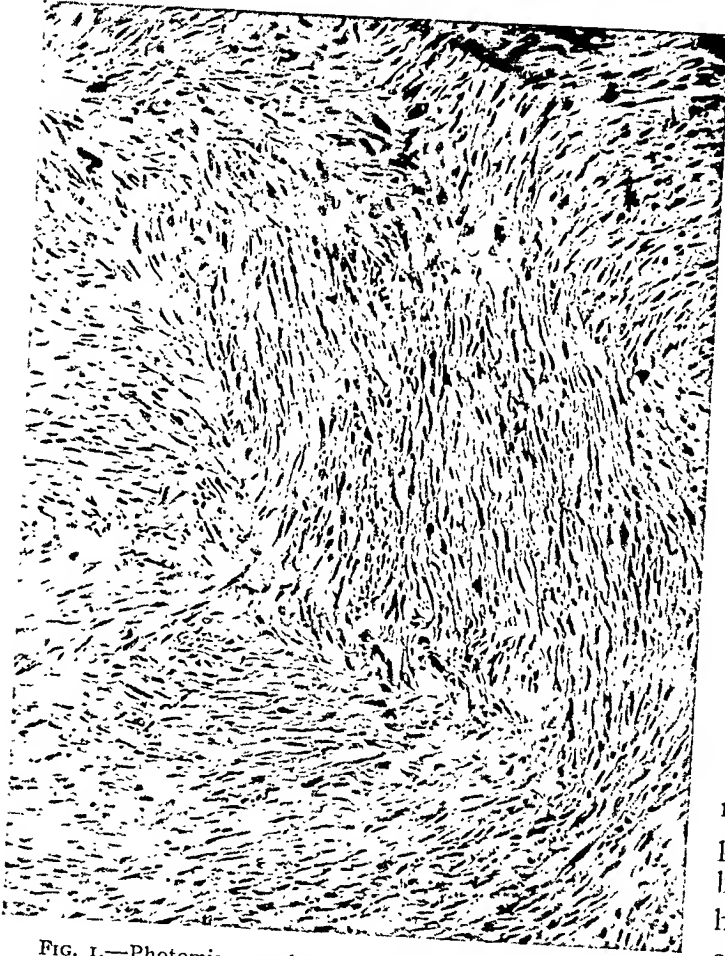


FIG. 1.—Photomicrograph showing neurogenic sarcoma of knee (Grade 1). This is the acellular fibrous type of growth which may be mistaken both histologically and clinically for simply fibroma. Each of three excisions was followed by prompt local recurrence. The patient is well seven years after amputation of the leg.

cells which probably have their origin in the endothelium of capillaries. The stroma is composed of mucin. Their specific structure would favor the view that these tumors are not of neurogenic origin. Tumors of this type have been found to be radiosensitive.

A myxomatous structure is frequently seen in neurosarcoma and in some neurogenic tumors this element is so predominant that the neurogenic origin is difficult to determine. In many cases in which the primary tumor has shown a definite neurogenic structure the histological picture of later recurrences has shown marked myxomatous features. Changes of this type may be attributed to spontaneous degenerative processes and probably also to

## NEUROGENIC SARCOMA

effects produced by radiation. Clinical analysis of those cases in which a myxomatous structure has been prominent fails to show any distinctive clinical characteristics with the single exception that a large proportion have been located in the thigh. Typical fascial myxosarcoma has been encountered in only one case. Because of their specific structure it is believed that a special attempt to correlate the clinical course with the microscopic picture may yield data which will permit a clinical pathological grouping of these tumors. From our present knowledge, however, unless the structure is typically that of fascial myxosarcoma, those tumors in which a myxomatous element is present should be regarded as neurogenic. The true nature of the so-called fascial myxosarcomas and their relation to neurogenic sarcoma must be left open to further study.

The true neurogenic sarcomas may be divided into the following groups:

Grade 1.—Acellular, fibrous tumors composed of large spindle cells, lying in a dense stroma of hyaline fibrous material. Cells few in number, stroma abundant. (Low grade of malignancy.)

Grade 2.—Cellular tumors composed of large spindle cells arranged in compact intertwining bundles with whorl formation, very little intercellular substance, cells predominant. (Moderate grade of malignancy.)

Grade 3.—Very cellular tumors composed of small spindle cells arranged in whorls and fasciculi, or polyhedral cells growing diffusely in a loose fibrillar network. (Highly malignant.)

Age.—Of one hundred cases of neurogenic sarcoma the ages were as follows:

1-10 years.....	2 cases
10-20 years.....	6 cases
20-30 years.....	12 cases
30-40 years.....	24 cases
40-50 years.....	21 cases
50-60 years.....	22 cases
60-70 years.....	10 cases
70-80 years.....	3 cases

The youngest patient was six, the oldest seventy-two years of age.

Sex.—Of 100 cases, 60 were males and 40 females, giving a ratio of 6 to 4.

Trauma.—Fourteen patients out of a group of 72 gave a history of trauma which they associated with the appearance of the tumor. The determination of the rôle played by trauma in the genesis of tumors is most difficult. Whereas in most instances the association between the two is very remote and unlikely the relationship in some cases is suggestive. Chronic irritation or repeated traumatic insults are probably more important than a single injury. One patient whose occupation was a cutter developed a tumor on the thumb just at the point which was constantly irritated by scissors used in cutting cloth. One professional dancer developed a tumor of the inner aspect of the thigh which was subjected to repeated trauma in a dancing act. Although these cases are suggestive, they cannot be regarded as con-

clusively demonstrating this relationship. The absence of trauma and irritation in many cases with similar tumors in similar locations leaves the question open to further study.

The anatomical distribution of one hundred cases of neurogenic sarcoma was found to be as follows:

Lower extremity, 44: (Thigh, 29; popliteal space, 8; lower leg, 6; foot, 1.) Upper extremity, 20: (Upper arm, 11; forearm, 8; thumb, 1.)

Chest wall, 18; abdominal wall, 6; neck, 6; buttock, 2; axilla, 2; groin, 1; scalp, 1; total, 100 cases.

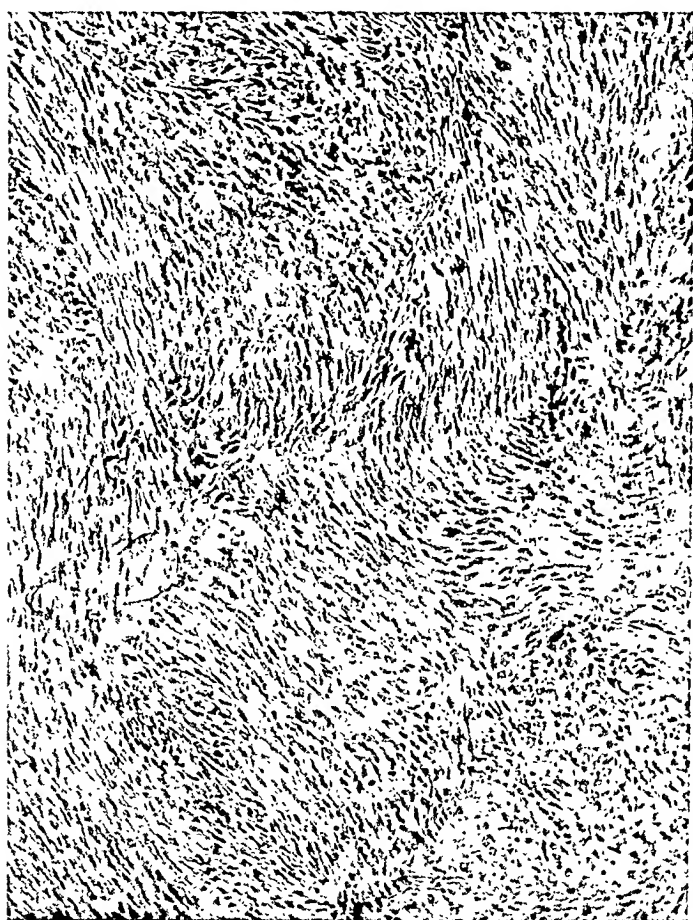


FIG. 2.—Photomicrograph showing neurogenic sarcoma (Grade 2). The structure is more cellular and less fibrous and presents the typical whorl formation characteristic of the neurogenic tumors.

*Tumors of the Popliteal Space.*—Of eleven neurogenic tumors of the popliteal space, two were primary and nine recurrent. The number of recurrences varied from one to seven. Five patients are alive and six are dead. An analysis of the cases which are well reveals that the treatment consisted of amputation in three instances, wide local excision in one and radiation alone in one. All three of the patients cured by amputation and free of disease, three, five, and seven years, respectively, had recurrent inoperable tumors. One large primary growth, 7 x 9 cm., was excised. The patient is free of disease two

years and nine months. The tumor was well encapsulated and the line of excision wide of the disease. One large recurrent inoperable tumor measuring 7 x 9 cm., treated heavily with combined external and interstitial radiation (radium packs and bare tubes), is well and free of disease four and one-half years. The tumor gradually disappeared and was replaced by scar tissue; the functional result is excellent, with full motion in the knee.

Six patients with popliteal tumors failed to survive. One died of pulmonary metastasis twelve months after amputation. In this case two previous excisions were followed by rapid recurrences. A third local excision was performed, bare tubes were implanted in the operative wound and five weeks

later one radium pack was applied (18,000 mc. hrs. at 10 cm.). Two months later a local recurrence was observed, and amputation was performed, followed one year later by death from pulmonary metastasis. The structure of this tumor was extremely cellular and malignant and tumor cells were found growing in blood-vessels.

One advanced recurrent inoperable tumor of the popliteal region was treated with active deposit of radium and bare tubes. The patient died four months later of pulmonary metastasis. One very cellular recurrent tumor treated heavily with radium packs and bare tubes died of pulmonary metastasis two years after treatment was begun. One large recurrent tumor was treated with the radium pack (15,000 mc. hrs. at 10 cm.) and excised one month later. The tumor was encapsulated, measured  $9 \times 7 \times 4$  cm. and on section proved to be a highly cellular spindle and small cell vascular neurogenic sarcoma. No post-operative radiation was employed and the patient was free of recurrence for almost two years when he developed a local recurrence, and died soon afterward of pulmonary metastasis. One small recurrent tumor  $2\frac{1}{2}$  cm. in diameter disappeared under treatment with small doses of low voltage X-rays. The patient was apparently free of disease for four years when she developed pulmonary metastasis and died. One small primary tumor  $2 \times 3$  cm. was excised and recurred four months later. The recurrence was treated with zinc chloride paste and radium packs. The patient died two months later of pulmonary metastasis.

It should be noted that the failures listed in the non-amputation group, treated by the more conservative methods of radiation or local excision or by both methods cannot be attributed to the advanced stage of the disease, as one presented a small primary growth  $2 \times 3$  cm. in diameter and another a small recurrent tumor only 2 cm. in diameter. The two outstanding features in this group of cases are the inadequacy of the treatment employed and the highly malignant nature of the tumors. In one case no radiation was employed and the local excision of a small primary growth  $2 \times 3$  cm. was followed six months later by death from pulmonary metastasis. In all the other cases radiation was of a miscellaneous variety and insufficient to sterilize a neoplastic process of the radioresistance known to be characteristic of these tumors.

*Tumors of the Upper Extremity.*—Out of five patients on whom an amputation was performed for neurogenic sarcoma of the upper extremity two are alive five and eight years respectively, and three died of pulmonary metastasis soon after amputation. Of the nine patients on whom no amputation was performed, three died and five are well five to nine years.

*The Amputation Cures.*—Of the two patients cured by amputation one had a tumor of the upper arm and one of the forearm. In one patient twenty-one excisions had been followed by as many recurrences. Two further attempts at local removal failed and amputation was finally performed. The patient is well five years after amputation. In the other case a recurrent tumor of the forearm failed to respond to buried radon implants and was



cured by amputation. The patient is well and free of disease eight years after amputation.

*The Amputation Failures.*—One patient with an extensive tumor of the upper arm was treated with bare tubes and later by amputation because of severe pain and œdema. Four months later a local recurrence was noted in the stump, and three months later death occurred from pulmonary metastasis. Histologically, the tumor was highly cellular and very malignant and a poor

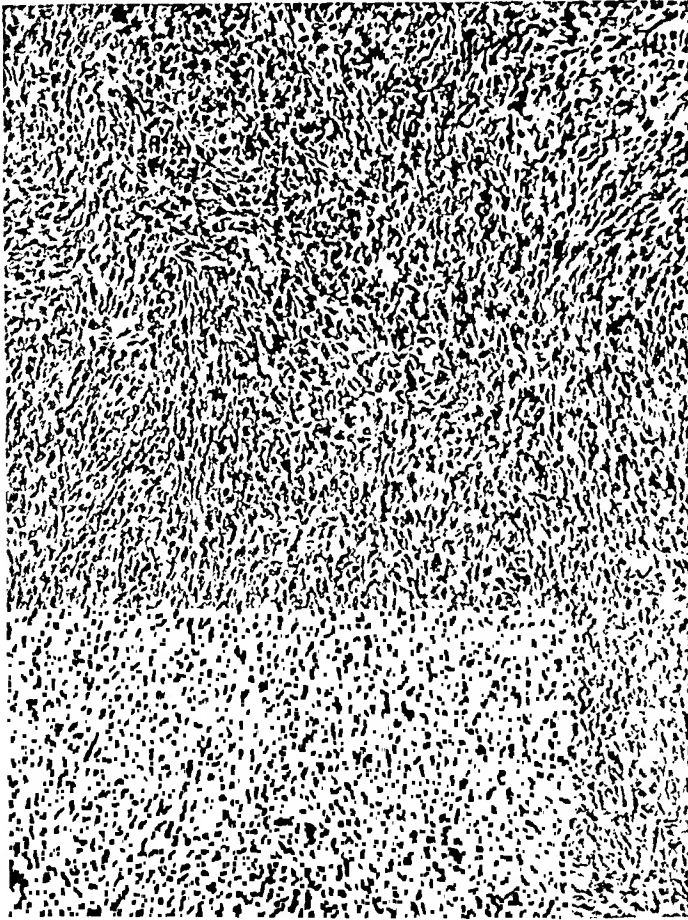


FIG. 3.—Photomicrograph showing highly cellular and malignant neurogenic sarcoma (Grade 3). The tumor is composed of small spindle and polyhedral cells closely packed with very little intercellular stroma. Neurogenic features are present but less distinct on account of the diffuse growth.

prognosis was predicted from the microscopic structure. In one recurrent tumor of the forearm, amputation was performed and followed eighteen months later by pulmonary metastasis, and death. No radiation was employed. Histologically, the tumor was cellular, very vascular and highly malignant. A small recurrent tumor of the wrist was subjected to amputation and followed four months later by recurrence in the stump and three years later by death from pulmonary metastasis.

An analysis of this group with an attempt to determine any factors which may have contributed to the results reveals no relation between the extent of

disease or number of previous recurrences and the final result. The one significant factor which seems to bear some relation to the results is the degree of malignancy of the tumor. In practically all the patients who died after amputation the structure of the tumor was unusually cellular. In the two instances tumor cells were found growing in blood-vessels. Contrasted with the highly cellular structure of the tumors in this group, the structure in the other group in which amputation was followed by cure was distinctly less cellular and more fibrous in character.

*Cases Treated Without Amputation.*—Nine patients with tumors of the arm were treated by the more conservative methods of radiation, local exci-



sion or both. Three of these died and six are living from two to nine years. The three patients who died had recurrent tumors which were treated by buried radon implants, alone in two instances and combined with local excision in a third. All developed repeated recurrences and finally died of pulmonary metastasis. The extent of disease in this group was not more advanced than in the group of six cases which are well. The method of treatment, however, differed markedly and it is to this that the difference in the results is attributed. Abstracts of the six patients free of disease from two to nine years appears in another section of this paper.

#### SUMMARY OF RESULTS OF TREATMENT OF TWENTY-FOUR NEUROGENIC TUMORS OF THE EXTREMITIES

Twelve well: Five amputation; seven non-amputation.

##### *Non-amputation Group*

(a) Prolonged external radiation of a large primary tumor of the arm followed by cautery removal. Well three years.

(b) Wide excision of a large primary tumor of the popliteal space. No radiation. Well three years.

(c) Extensive, recurrent, inoperable popliteal tumor treated by heavy external radiation and bare tubes. Well four and a half years.

(d) Small recurrent tumor of forearm excised and followed immediately by post-operative external radiation. Well seven years.

(e) Extensive, recurrent, inoperable tumor of upper arm treated by exposure and implantation of bare tubes, external radiation and Coley's toxins. Well six years.

(f) Recurrent tumor of arm excised and followed immediately by post-operative radiation with radium packs. Well nine years.

(g) Large recurrent tumor of arm excised, and the base treated with zinc chloride paste. Well five years.

Twelve died: Four amputation; eight non-amputation.

##### *Non-amputation Group*

(a) Five cases. Primary and recurrent tumors treated by repeated excision and inadequate radiation. Repeated recurrences followed by death from pulmonary metastasis.

(b) Extensive recurrent tumor treated with bare tubes and active deposit of radium. Death from pulmonary metastasis.

(c) Small primary growth in popliteal space excised. No radiation. Death from pulmonary metastasis four months later.

(d) Small recurrent tumor treated by inadequate external radiation. Death from pulmonary metastasis one year later.

*Tumors of the Thigh.*—Out of fifteen patients with tumors of the thigh, thirteen are dead and two are alive. The microscopic structure showed neurogenic sarcoma in five cases; myxosarcoma in five; and in five cases, the structure was essentially myxosarcoma but neurogenic features were present. Five patients had advanced primary growths; six had advanced recurrent tumors, two had early recurrent tumors, and one patient was admitted for post-operative radiation following the local excision of a recurrent tumor. Amputation was attempted in one case. A primary tumor 6 x 7 cm. on the anterior surface of the thigh was incised and a biopsy taken. The structure showed a myxosarcoma. Three months later an amputation was performed and followed eight weeks later by death from pulmonary metastasis.

The treatment of the other twelve patients who succumbed to the disease varied. In some cases it consisted of excision alone; in others, excision and implantation of bare tubes. The inoperable cases were treated mainly by exposure and insertion of bare tubes. Several patients were treated by zinc chloride paste alone or combined with radiation. In practically none of the cases was heavy external radiation employed. Many of these failures must be attributed to the advanced stage of the disease. That this is not the

sole factor however is demonstrated by the following case:

One small recurrent tumor 3 cm. in diameter, on the inner aspect of the thigh, was excised and bare tubes were implanted in the tumor bed. Examination of the specimen revealed a well-encapsulated tumor which microscopically proved to be a myxosarcoma probably of neurogenic origin. No external radiation was employed. Eight months later a local recurrence was observed which disappeared under external radiation but recurred. The patient died two years later of pulmonary metastasis. In this case the tumor was small and

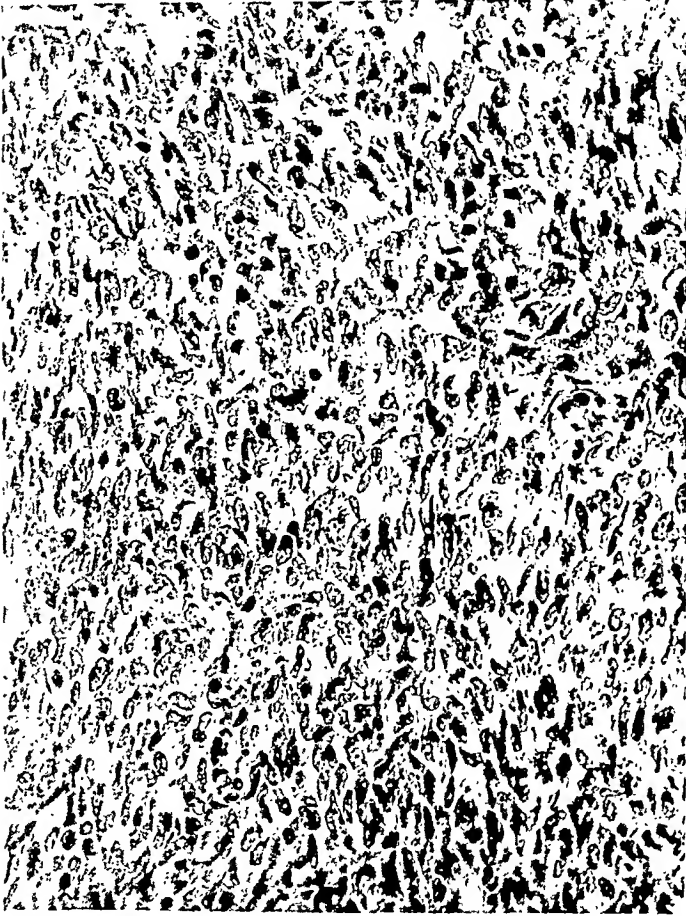


FIG. 4.—Photomicrograph showing high power of No. 3. Note the hyperchromatism and atypical quality of the cells and the numerous mitotic figures.

encapsulated—yet it recurred promptly and finally caused the death of the patient. It is believed that the failure to use post-operative external radiation may have been a factor in this result. Two of the fifteen patients with sarcomas of the thigh are well, two and five years, respectively, and are described in detail in a separate section of this paper.

*Tumors of the Neck.*—Out of five patients with neurogenic tumors of the neck, two died, two are good palliative results and one is free of disease, fifteen months after combined excision and radiation. Both patients who died had advanced recurrent tumors which were treated by small doses of external radiation. Two advanced inoperable tumors of the neck, one primary and the other recurrent, are being held in check by high voltage X-rays and

radium packs. Treatment was begun two years ago. The patients are in excellent general condition. The pain has been markedly relieved and the growth of the tumors arrested. One primary operable tumor was excised and the excision followed by one radium pack. The patient is free of disease sixteen months.

*Tumors of the Chest Wall.*—Out of nine patients with tumors on the chest wall five are alive and four died. Of those who died one had a very extensive tumor of the axilla which was treated by external radiation. The patient died two months after treatment was begun. One patient when first seen presented a mass on the shoulder 10 cm. in diameter, the fifth recurrence. Small doses of radiation and desiccation failed to control the disease and death occurred one year after treatment was begun. In the other two patients with recurrent tumors of the chest wall the disease was partly controlled by small doses of radiation, just insufficient however to completely eradicate the disease. They lived for five years and finally died of pulmonary metastasis.

Of the five patients who are well the growth of the tumor was arrested in three and two patients are free of disease. These patients have been under observation for only two and a half years, so the time is still too short to permit deduction as to ultimate results. One primary tumor of the shoulder treated by radium packs and low voltage X-rays has been held in check for two years. One extensive recurrent tumor of the shoulder has been held in check for one year by heavy external radiation. One primary tumor of the deltoid region treated with low voltage X-rays for one year failed to respond and was recently excised. One primary tumor of the shoulder excised and followed by post-operative radiation (low voltage X-rays) is free from recurrence one year. A recurrent tumor of the anterior chest wall heavily radiated and removed three months later by zinc chloride paste is free from recurrence one year.

*Pulmonary metastasis.*—Fifteen of the seventy-five patients (20 per cent.) are known to have developed pulmonary metastasis. Microscopic examination of the metastasizing tumors revealed a highly cellular structure in all. In four cases the structure was myxosarcoma. In the remainder of the group the tumors were very cellular and composed of small round and spindle cells actively growing and frequently invading the walls of the blood-vessels. In no case was pulmonary metastasis observed from the acellular fibrous type of growth. The relationship between the highly cellular nature of some of the tumors and their metastasizing property is very definite, so that the microscopic structure may serve as a fairly accurate and often useful guide in prognosis and treatment.

*Radiation as an Aid to Diagnosis.*—Although the clinical diagnosis of neurogenic sarcoma is relatively simple, occasionally these tumors may be confused with other lesions. Two instances in which an error in diagnosis was made illustrate the value of radiation as a diagnostic test. In one case an extensive primary soft part tumor of the back showed a phenomenal

response to radiation and disappeared almost entirely under treatment with radium packs. In another case a similar primary rapid regression and disappearance of a tumor of the buttock occurred. Both tumors presented all the clinical features of a neurogenic sarcoma. Later histological examination of the tumors revealed a very cellular malignant round and polyhedral cell tumor of undetermined origin in the first case and a lympho-sarcoma in the second. Neither tumor belonged to the class of neurogenic sarcomas.

In no case of neurogenic sarcoma, even of the most cellular variety, has

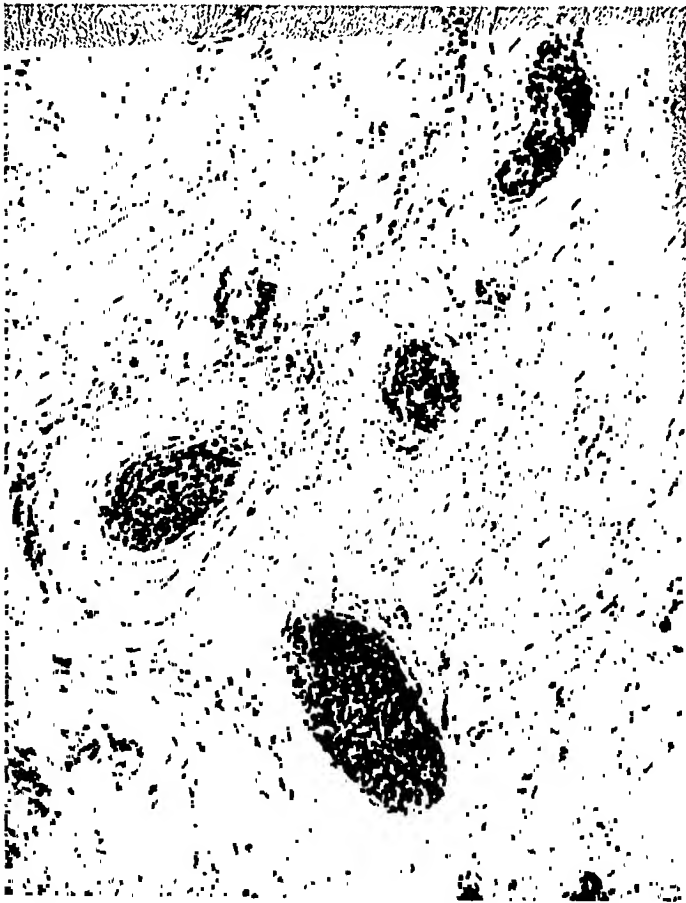


FIG. 5.—Photomicrograph showing cellular neurogenic sarcoma growing in blood-vessels. The patient died of pulmonary metastasis twelve months after amputation of leg.

a very rapid response to small doses of radiation been observed. This group of tumors in general is resistant to radiation and response occurs slowly and months after radiation of an intensive type. Small doses of radiation effect their growth to a very limited extent. In view of these observations a small dose of radiation, such as a single suberythema dose of low voltage X-rays, may serve as a useful diagnostic test in differentiating the radioresistant neurogenic sarcomas, from the radiosensitive tumors with which they may be confused, such as lymphosarcoma, or obscure malignant cellular tumors not of neuro-

genic origin. The test is of practical value from a therapeutic standpoint as the method of treatment is entirely different in the two instances. By detecting and excluding the highly malignant radiosensitive tumors not of neurogenic origin, surgery is scrupulously avoided, and these cases are treated by external radiation alone, whereas the attack upon the radioresistant neurogenic sarcoma is by the combined methods of surgery and radiation. Because of the fact that of the two varieties of tumors which simulate each other, one is extremely radioresistant and the other radiosensitive, the therapeutic test may be of considerable value in the differential diagnosis and may serve as a useful guide in treatment. The information obtained by this method may be sufficient to enable the execution of proper therapeutic

measures without the necessity of incising the growth for biopsy. Whereas the latter procedure may be of little harm in case the growth proves to be a neurogenic sarcoma, the incision of a lymphosarcoma is distinctly harmful and is to be avoided.

*Amputation.*—Tumors of the extremity in which amputation offers a chance of completely eradicating the disease present an important problem in treatment. The decision between amputation on the one hand and excision and radiation on the other is at times most difficult. Out of ten amputations performed for neurogenic tumors of the extremity, five patients are well and five died of pulmonary metastasis soon after amputation. On the other hand, out of fifteen tumors of the extremity treated by local excision and radiation eight patients died and seven are alive from two to nine years.

In a comparison of the results of the two methods of treatment, a consideration of the extent of the disease in each group is most important. An analysis of the amputation failures reveals that the disease in these cases was not more advanced than in the group of successful amputations. In two patients the tumors were small primary lesions and in two others the recurrences were small, whereas several tumors cured by the more conservative methods of excision and radiation were advanced recurrent growths. The only tangible feature derived from a study of the amputation failures is the highly cellular and malignant nature of the tumors in this group. It would seem from our data that the success or failure to cure by amputation depends mainly upon the degree of malignancy of the tumor, the highly cellular growths being not infrequently followed by pulmonary metastasis.

Analysis of the results of treatment by the more conservative measures of excision and radiation reveal that seven out of fifteen patients are well from two to nine years. These results compare most favorably with those from amputation, especially since the extent of the disease was fully as great in this group as in the amputation group. Furthermore, an analysis of the eight failures indicates an outstanding inadequacy of the radiation employed compared with that employed in the cured cases.

Our results in the treatment of tumors of the extremities with reference to amputation seem to justify the belief that pre-operative radiation and wide local excision followed by prompt and adequate post-operative radiation is the method of choice in the treatment of the operable tumors. The procedure in the primary or recurrent inoperable tumors must be determined in each individual case and involves a consideration of a number of factors such as the extent of the disease, the expected functional result and the histological structure of the tumor. A number of excellent results by combined external and interstitial radiation encourage this procedure in advanced inoperable cases in which the growth is acellular and in which distant metastasis is unlikely. The decision between amputation and radiation in this group is very difficult and must remain open, awaiting further observations on the results of improved radiation therapy. It is believed that the radiation results can be vastly improved by increasing the doses of external radiation

to the limit of skin tolerance and combining with it interstitial radiation in selected cases.

# DISCUSSION OF CURED CASES

In an analysis of the favorable results it is important to determine to what extent the cures are due to the early stage of the disease and the extent to which other factors such as the degree of malignancy and especially the type of treatment employed are responsible for the cures. In the five amputation

cures the results are attributed primarily to the radical procedure of amputation. The nature and extent of the disease in this group is partly indicated by the number of previous recurrences which varied from three to twenty-three.

A review of the eighteen favorable cases from the standpoint of the extent of disease reveals that ten of the patients were in an advanced stage of the disease. Five of these were subjected to amputation and the other five cases, all inoperable tumors, are excellent radiation results. Of the other eight cases, seven were small operable tumors cured by exci-



FIG. 6.—High power photomicrograph showing very cellular and malignant neurogenic sarcoma (Grade 3). Note mitotic figures.

sion and post-operative radiation, and one was a large operable encapsulated tumor cured by excision alone. Histological examination of the tumors in the cured group was made with particular emphasis on the degree of malignancy. Fifteen sections were available for study. They were found to fall into the following groups:

Grade 1 (Acellular, fibrous) .....	7 cases
Grade 2 (More cellular—large spindle cells) .....	5 cases
Grade 3 (Highly cellular, small spindle and round cells) .....	3 cases
Total .....	15 cases

It may be seen from this grouping that the histological structure indicates

a relatively low grade of malignancy in twelve of the cured cases and a highly cellular and malignant structure in only three cases. It would seem from this data that the degree of malignancy as indicated by the cellular structure is one of the most important factors in the prognosis of the disease.

*Treatment.*—The ability to completely eradicate the disease by wide local excision alone is demonstrated by several cases cured by this method. It should be pointed out, however, that in these cases the tumors were encapsulated and not very cellular. These rather unique results are therefore not to be regarded as evidence against the use of radiation in the treatment of these tumors. The marked frequency of recurrences following surgical removal is largely due to the fact that the serious nature of these small movable tumors is unrecognized and the excision is not made sufficiently wide of the disease. That other factors are involved, however, is demonstrated by a number of instances in which even the wide excision of small and often encapsulated tumors is followed by prompt recurrence and pulmonary metastasis. Histological examination has shown these tumors to be of a highly cellular and malignant nature. Because of the radioresistance of these tumors it is believed that method of choice in the treatment of the operable group is surgery combined with radiation. The absolute necessity of post-operative radiation in the treatment of neurogenic sarcoma is amply demonstrated by our data. The marked tendency to recurrence, the uncertainty of complete removal, and the appearance of new tumors along the course of the same nerve in certain forms of the disease necessitate other agents as adjuvants to surgery in the prevention of recurrence and cure.

Although the principle of post-operative radiation is the same here as in other neoplastic diseases, these tumors present a peculiarly favorable setting for the employment of this agent. Many cases in which repeated excisions had been followed by prompt recurrences received post-operative radiation soon after their last excision and have remained free from recurrence for over five years.

A striking group of cases is that in which the patients, previously subjected to several operations were seen so soon after the last excision that the differentiation between post-operative reaction and local recurrence was still difficult. In some cases only a thickening in the scar was evident, whereas others presented definite recurrences. External radiation was instituted immediately. There are six cases of this type. All the patients are well and free of disease four and a half to nine years. A very suggestive feature of this group of cases in the short interval between the excision and the post-operative radiation. It is suggested that the good results obtained in this group of cases may be due largely to the promptness with which radiation was instituted. Certain theoretical consideration and histological study of radiated tissues lend support to this view. Tumor cells which have become incarcerated in strands of connective tissue in a dense post-operative scar,



are more resistant to radiation than tumor cells which are in a vascular, non-fibrous, granulating wound where the cellular reaction is pronounced and young capillaries and fibroblasts are abundant.

Based upon these observations it would seem that to be most effective against recurrence, radiation should be instituted soon after excision and the operative area radiated before formation of scar tissue. In this way foci of tumor cells are exposed to radiation when they are more radiosensitive

because of a favorable tumor bed reaction. By radiating at this stage, sterilization of the operative field may perhaps be accomplished by a smaller amount of radiation than is necessary after the scar tissue formation.

In the inoperable group, radiation has been employed in an attempt to arrest and control the disease and to relieve pain. Although many of the patients in this group succumbed to the disease, a small but definite proportion has yielded very encouraging results and demonstrate what can be accomplished even in apparently hopeless cases. Our experience in the treatment of these tumors

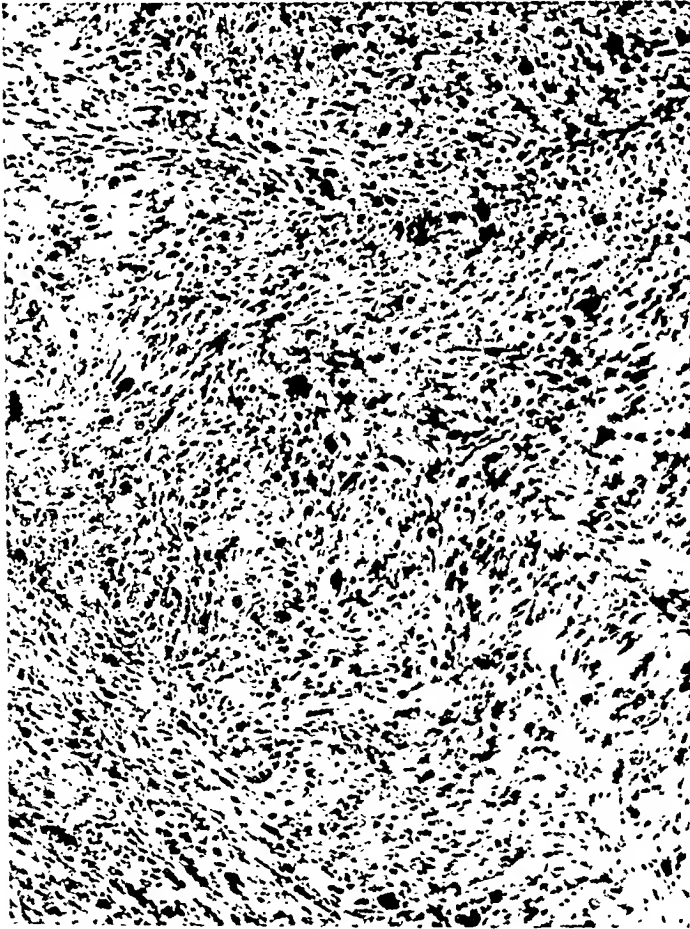


FIG. 7.—Photomicrograph showing cellular neurogenic sarcoma with giant cells of a foreign body type.

indicates that radiation in order to be effective must be intensive. Heavy external radiation aided by interstitial radiation in selected cases are the methods that have produced the best results. By this method, alleviation of pain, regression of the tumor, and arrest of the disease may be expected in many cases and eradication of the disease and cure in a few.

In general, the plan of treatment should consider the principle that these tumors are very radioresistant and the treatment so planned as to deliver to the tumor a maximum quantity of radiation through multiple portals of entry in the skin. Rapid regression is not to be expected even after intensive radiation. Reaction to radiation may be long delayed and many months may elapse before the effects of radiation can be observed. Once regression has begun,



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complete disappearance of an extensive tumor may take place as a latent radiation effect.

### SUMMARY AND CONCLUSIONS

1. Based upon the belief that most of the subcutaneous and intermuscular tumors, commonly designated as fibrosarcoma, spindle-cell sarcoma, and fascial sarcoma are of neurogenic origin, all tumors presenting these features have been included under the term of neurogenic sarcoma.

2. The serious nature of these small movable subcutaneous tumors is generally unrecognized. They are commonly regarded as benign fibromas. Repeated incomplete excisions frequently result in local recurrences, in a stage of the disease in which radiation and adequate surgery would result in a cure.

3. Because of the radioresistance of neurogenic sarcoma and radiosensitivity of those tumors with which they may be confused clinically, the therapeutic test may be of practical value in the differential diagnosis. Since the method of treatment depends largely upon the nature of the tumor process, the information obtained may be of considerable value from a therapeutic standpoint.

4. Of twenty-four patients with tumors of the extremities (excluding tumors of the thigh) twelve died and twelve are alive and free of disease from three to nine years. Five of the cases are amputation cures and seven are cures affected by the conservative measures of excision or radiation, or the combined method.

5. Neurogenic sarcomas of the thigh offer a bad prognosis. Only two out of fifteen patients are alive. The structure frequently encountered in this group is myxosarcoma. The unfavorable location and the high grade of malignancy are factors accountable for the unfavorable results.

6. Ten amputations for tumors of the extremity resulted in five cures and five deaths from pulmonary metastasis. The histological structure in the amputation failures was unusually cellular and highly malignant. It is believed that the result of amputation depends upon the degree of malignancy of the tumor process rather than upon the extent of the disease.

7. Eighteen patients with neurogenic sarcoma are well and free of disease from three to nine years. Seven were small operable tumors cured by excision and post-operative radiation. Of eleven advanced tumors, five were cured by amputation, one by wide local excision and five advanced inoperable cases are excellent results obtained by intensive external and interstitial radiation.

8. Twenty per cent. are known to have developed pulmonary metastasis. The histological structure of all these tumors was highly cellular and malignant. (Grades 2 and 3.) In no case was pulmonary metastasis observed from the acellular fibrous type of growth. (Grade 1.)

9. An analysis of the failures reveals three outstanding features—the highly malignant nature of the tumor process; the advanced stage of the disease; and, the inadequacy of the treatment employed. Hence, incomplete

excision; attempted excision of inoperable tumors; and, inadequate radiation are held responsible for many of the unfavorable results.

10. Whereas wide local excision of the acellular fibrous tumors may result in a cure, this procedure is frequently followed by local recurrence and pulmonary metastasis in the highly cellular and malignant tumors. Since the degree of malignancy cannot be determined clinically, pre-operative radiation is indicated in all neurogenic tumors in an attempt to obviate the rapid recurrence following simple excision of the very malignant type.

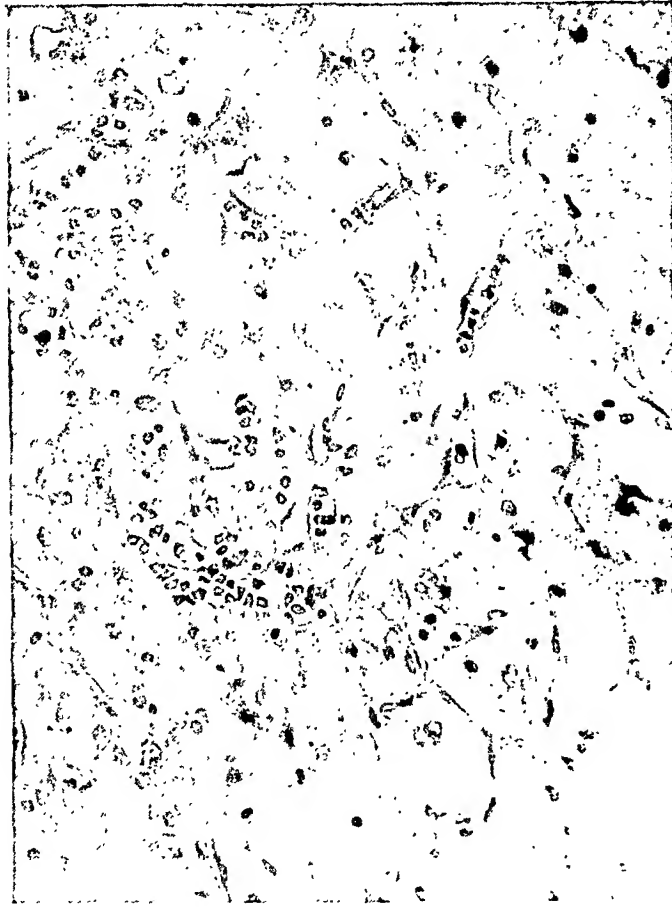


FIG. 8.—Photomicrograph showing fascial myxosarcoma. The tumor is composed of cells probably arising from the capillary endothelium and forming capillaries. The stroma is mucinous.

11. Heavy external radiation alone or combined with interstitial radiation are the methods employed in the treatment of the inoperable tumors. By this method relief of pain and arrest of the disease has been accomplished in many cases and complete cure in some.

12. Our studies indicate that pre-operative radiation followed by wide local excision and immediate post-operative radiation is the method of choice in the treatment of the distinctly operable neurogenic tumors (excluding the extremely cellular type).

13. The rapid response of a soft part subcutaneous tumor to external radiation is an indication of its highly cellular and malignant nature and a contra-indication to either interstitial radiation or surgical removal. Prolonged external radiation is the method of choice in the treatment of this type of growth.

#### CURED CASES

CASE I.—J. St. A., male, age forty-two, admitted October 17, 1919. Small tumor of forearm  $2\frac{1}{2}$  cm. in diameter removed three years before and recurred nine months later. Recurrence removed one year after first operation. Second and third operations followed by recurrences. On admission patient had a tumor  $6 \times 6$  cm. on the flexor surface of forearm. No improvement following insertion of bare tubes. Amputation January 15, 1920. Microscopic examination revealed a large spindle-cell neurogenic sarcoma. Well seven years.

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CASE II.—Male, age eleven, admitted March 10, 1921. Three soft fluctuating tumors on inner aspect of knee with complete ankylosis at the knee. Fifth recurrence. Three radium packs (24,000 mc. hrs. at 6 cm.). In September, 1921, followed in February, 1922, by amputation. Microscopic examination revealed a very cellular, small, spindle-cell neurogenic sarcoma. Well five years.

CASE III.—J. A., male, age thirty-seven, admitted February 9, 1920. Just below the knee there was an ulcerated crater 7 cm. in diameter surrounded by firm tumor tissue, third recurrence. Has had 23 X-ray treatments elsewhere. Local excision and radium pack followed by recurrence. Amputation April 28, 1920. Microscopic examination showed a large spindle-cell neurogenic sarcoma. Well seven years.

CASE IV.—A. W., male, age sixty, admitted April 10, 1920. Twenty-one excisions in past ten years followed by as many recurrences. On admission there was a small recurrence the size of a marble on the outer aspect of the humerus. Radiation, excision, zinc chloride paste, and desiccation all resulted in repeated recurrences. Amputation performed on July 15, 1921. Microscopic examination showed a large spindle-cell neurogenic sarcoma. Well six years.

CASE V.—P. C., male, age nineteen, admitted January 15, 1923. Examination showed an ulcerated recurrent tumor on outer aspect of knee (seventh recurrence). Removal with zinc chloride paste attempted but discontinued because of proximity to blood-vessels.

Amputation January 2, 1924. Microscopic examination showed a small spindle-cell neurogenic sarcoma. Well three years.

CASE VI.—F. V., male, age forty-four, admitted July 27, 1924. Small, firm, subcutaneous mass the size of a hazelnut has been present in popliteal space for many years, began to grow rapidly eighteen months ago. On examination there was a circumscribed firm nodular mass 3 x 6 x 8 cm. in the left popliteal space. Wide excision of growth on August 1, 1924. No radiation. Microscopic examination revealed a spindle-cell neurogenic sarcoma. The patient is now well and free of disease three years.

CASE VII.—F. H., female, age thirty. Admitted March 3, 1924. Primary tumor in lower abdominal wall, 3 x 4 x 5 cm., first noticed three months before admission. One low voltage X-ray exposure was followed two days later by wide local excision. The patient is well and free of disease three years. Microscopic examination showed a neurofibrosarcoma.

CASE VIII.—C. F., female, age thirty-eight, admitted March 20, 1920. Four months before admission, small mass which had formed in vaccination scar on arm, was removed and recurred soon afterward. Examination showed a nodular mass 2 x 2½ cm. adherent to the scar. Wide excision of mass. Base of wound treated with zinc chloride paste followed by skin graft. Microscopic examination showed a neurogenic sarcoma. Patient free of disease—six years. (No radiation.)

CASE IX.—J. I., age sixty-three, admitted January 31, 1921. Very large primary tumor occupying middle and upper thirds of humerus. Tumor measured 20 cm. in length. Biopsy specimen showed a neurogenic sarcoma. Treatment consisted of prolonged radiation with low voltage X-ray and Coley's toxins. For six months there was no change in size of tumor. Reduction in mass first noted ten months after treatment was begun. In June, 1925, cautery removal of ulcer resulting from radiation—no tumor tissue found in specimen—ulcer gradually healing. No evidence of tumor at present. Functional result good. (Radiation consisted of ten low voltage X-ray exposures given over a period of sixteen months.)

CASE X.—Female, age twenty-five, admitted April 8, 1920. Mass about size of foetal head in right lower quadrant involving the abdominal wall extending below Poupart's ligament. At operation the tumor was found to be extraperitoneal and inoperable. Twenty-three bare tubes were distributed throughout the mass and four weeks later twenty-five more bare tubes were inserted. (Total, 4672 inches.) Heavy external

radiation was given (nine exposures within two years with radium packs; total, 74,000 mc. hrs. at 6 cm.). Biopsy specimen showed a spindle-cell neurogenic sarcoma. One year after radiation was begun there was a marked diminution in the size of the mass. Pain has been relieved, general condition of patient good. Growth arrested seven years.

CASE XI.—M. K., female, age thirty-four, admitted November 22, 1921. Large recurrent tumor of upper arm. Exploration revealed an extensive inoperable tumor infiltrating muscles. Amputation was refused. Nine bare tubes were inserted (15 millicuries), and the wound closed. Two radium packs were applied, each 8000 mc. hrs. at 6 cm. one month apart. Two years later an exploratory incision was made, but no tumor found. Coley's toxins were administered for two years. Patient is well and free from recurrence six years. Microscopic examination showed a neurogenic sarcoma.

CASE XII.—Female, age thirty-one, admitted November 10, 1922. Three and one-half years ago developed a small mass in scalp which grew rapidly. Four local excisions followed by as many recurrences. Last operation done six months before admission. Examination revealed a recurrent tumor the size of a hen's egg. At operation the main part of the mass was excised, but a small fragment of tumor adherent to the periosteum could not be removed. Post-operative radiation was instituted on the first day after operation and was continued at intervals over one month. During this period she received 60,000 mc. hrs. at 6 cm. (radium pack). The patient is well and free of disease four and a half years. Examination of the tumor showed a neurogenic sarcoma.

CASE XIII.—C. B., female, age twenty-nine, admitted December 13, 1917. Third recurrence of a tumor of the forearm removed five weeks before admission. Examination revealed œdema of the arm, but no definite recurrence. Treatment consisted of radium pack on December 17, 1917—12,150 mc. hrs. (filtration 0.5 mm. silver plus 2 mm. lead—distance 6 cm.) and five days later 3250 mc. hrs. at 6 cm. (total 21 hours). Patient is well and free of recurrence nine years. (No sections.)

CASE XIV.—H. L., male, age fifty-four, admitted November 8, 1919. Second recurrence of mass in forearm removed three weeks before admission. Has had three X-ray treatments. Examination revealed a healed six-inch scar on the dorsum of the forearm with some thickening around the scar, but no definite recurrence. Radiation consisted of six low voltage X-ray treatments given over a period of eight months. Microscopic examination of the tumor revealed a large spindle-cell sarcoma, neurogenic type. The patient is well and free of recurrence seven years.

CASE XV.—B. C., female, age forty-five, admitted September 27, 1921. A small pea-sized nodule in the outer aspect of the thigh was noticed in 1910. Five years later it began to grow rapidly and was excised two weeks before admission. On examination there was an area of thickening and induration beneath the scar 3 x 4 x 7 cm. Treatment was instituted immediately and consisted of seven low voltage and two high voltage X-ray exposures (each 80 per cent. to 90 per cent. of an erythema dose) over a period of three years. On April 12, 1922, there was no evidence of disease. On September 28, 1926, there was no evidence of disease and the skin was normal except for a telangiectasis. Pathological examination showed a cellular infiltrating sarcoma of neurogenic origin. The patient is free of disease five years.

CASE XVI.—A. L., female, age twenty-two, admitted September 14, 1922. Mass in popliteal space first noted four months ago was removed three weeks before admission. Examination revealed a firm nodular recurrence 7 x 9 cm. attached to scar in the popliteal space. Treatment consisted of heavy external and interstitial radiation with radium packs and bare tubes (total 50,000 mc. hrs. radium packs, seven exposures within three months at a distance of 6 cm.). On January 5, 1923, twenty bare tubes were inserted (total, 3300 mc. hrs.). Seven months after treatment was begun there was no evidence of the tumor in the popliteal space. Microscopic examination of the tumor showed a large spindle-cell neurogenic sarcoma. The patient is well and free of disease four and a half years.

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CASE XVII.—Male, age twenty-three, admitted January 10, 1921. Two small masses present in upper abdominal wall for three years. Local excision eighteen months ago, followed by a recurrence which was removed three weeks before admission. Examination revealed a small recurrence in the scar about 2 x 3 cm. Radiation was begun three weeks after excision and consisted of three low voltage X-ray exposures (80 per cent. of an erythema dose each) given one month apart. The mass disappeared and the patient is now free of disease six years after operation. Pathological examination revealed a spindle-cell neurogenic sarcoma.

The authors are highly indebted to Dr. James Ewing who first established the disease as a clinical and pathological entity, for his invaluable aid and general supervision, without which this study would not have been possible. They also desire to express their thanks to Drs. W. S. Stone, W. B. Coley, R. Herendeen, L. F. Craver and Bradley Coley who have conducted the treatment of many of the cases for placing their material at the disposal of the writers.

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# BULLET FREE IN THE SPINAL CANAL CAUSING DELAYED NEUROLOGICAL MANIFESTATIONS

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THE sudden occurrence of sharp shooting pains in the legs and cramp-like abdominal pains two years after a gunshot injury is an unusual incident. In the study of this case little emphasis was, at first, placed on the bullet as a probable cause of the symptoms because the entire clinical picture was identical with that usually seen in tabetic crises. However, after more complete röntgenologic studies, the bullet was shown to be freely movable in the spinal canal. In a review of the literature it was found that foreign bodies free in the spinal canal were rarely seen; consequently this case was considered worthy of being placed on record.

*Review of the Literature.*—Many types of injuries to the spinal cord by bullets have been reported, but it is the purpose of this paper to review only those cases in which the bullet was freely movable in the spinal canal.

One of the earliest cases was reported by the Supervisor of the Marine Hospital<sup>1</sup> at Washington in 1885. The patient was a white male, twenty-six years of age, who had been shot in the back of the neck four months prior to his admission to that hospital. He had been "weak" since his injury and had had frequent mild attacks of twitching of his muscles of all parts of the body. These attacks became worse, and three weeks after admission he developed generalized convulsions. After several severe convulsions the patient died. At autopsy the coverings of the brain were congested. A .32 calibre bullet was found in the vertebral canal opposite the body of the atlas. The symptoms were caused by a gradual increase in the size of the cyst which had formed around the bullet, and death was attributed to the rupture of the cyst into the sub-arachnoid space.

In 1900, Pershing<sup>2</sup> gave a detailed account of a woman who had been shot in the back at the level of the eleventh rib about six inches to the left of the midline. The patient immediately became numb from the waist to the toes and was unable to move her legs. A short time later she began to have severe pains in the buttocks and lost control of her anal and vesical sphincters. The plantar reflexes, knee-jerks and Achilles reflexes were absent. The anal and perineal reflexes were active, although no sensation was present. The bullet was localized, by means of the Röntgen-rays, between the twelfth dorsal and the first lumbar vertebrae. At operation the bullet was free in the sub-arachnoid space but, due to the shift in the position of the patient, it had moved to the level of the upper part of the eleventh dorsal vertebra. Following the removal of the bullet there was no restoration of function, and the patient died three weeks later. The cause of death was not given in the report.

Loison and Mignon<sup>3</sup> in 1901 reported a case in which the bullet had penetrated into the sub-arachnoid space in the upper part of the lumbar region. The bullet remained free and fell to the bottom of the sub-arachnoid cul-de-sac. It was localized by means of the Röntgen-rays. At operation the bullet was not at the calculated place. Later more röntgenograms were taken and the bullet was again localized in the sub-arachnoid cul-de-sac at the level of the fourth lumbar vertebra. At the second operation the

cul-de-sac was opened but the bullet was not there. After thorough exploration with a cannula-sound the bullet was found six centimetres higher than the point of localization on the röntgenograms. This displacement was caused by the change of position of the patient prior to the operation.

Raymond and Rose,<sup>5</sup> in 1906, reported a case in which a bullet entered the back at the level of the second lumbar spinous process. The analysis of the symptoms and the röntgenologic examination gave the localization of the bullet at the inferior border of the third lumbar vertebra. A few weeks later the patient suddenly showed new and more severe symptoms and different localizing signs. Further röntgenograms showed the bullet at the inferior border of the first sacral vertebra. At operation the bullet was found to be freely movable in the sub-arachnoid space. After the removal of the bullet the patient recovered completely.

Bec<sup>6</sup> speaks of a shrapnel bullet which, by röntgenologic examination, was thought to be in the region of the second lumbar vertebra. On the basis of this examination the patient was operated upon, but the bullet was not found. Later, after numerous fluoroscopic examinations, it was demonstrated that the bullet had shifted its position in the spinal canal. At a subsequent operation it was found to be freely movable in the sub-arachnoid space. The bullet was successfully removed at this second operation, and the patient recovered.

Auvray,<sup>8</sup> in 1916, reported a very complete and comprehensive study of a

case in which the symptoms and findings were similar to those of the case which we are reporting. At the first röntgenologic examination the bullet was thought to be in the soft tissues of the back between the spinous processes of the fifth lumbar and the first sacral vertebrae. At operation, however, it was necessary to go deeper and deeper until finally a laminectomy was necessary, since it was then decided that the bullet was probably within the spinal canal. On exposing the dura a small irregular hole was found which, apparently, was the point of entrance of the bullet. Cerebro-spinal fluid escaped freely from that opening. The dura was opened and the bullet exposed. The bullet was difficult to grasp; consequently some trauma to the roots of the cauda equina resulted. Immediately following the operation the patient began to suffer from severe pains in his legs and marked general weakness. The operator attributed this pain to the injury of the nerve roots at operation. The patient made an almost complete recovery within a year.



FIG. 1.—Röntgenogram showing the position of the bullet opposite the first sacral vertebra.

Bulkley and Bergamini,<sup>12</sup> in 1919, reported a case in which a machine-gun bullet was freely movable within the spinal canal but outside of the dura mater. At operation, while attempting to grasp and remove the bullet, it slipped and thereafter could not be found. Further fluoroscopic examinations showed that the bullet had dropped to about the middle of the sacral canal. The nose of the bullet was engaged within a small loop at the end of a wire and the missile was readily withdrawn and removed through the operative wound. The patient regained control of the vesical sphincter twenty days after the operation. There was some improvement in the motor but none in the sensory paralysis. The patient developed generalized diffuse miliary tuberculosis and died four months later.

#### CASE REPORT

On August 2, 1926, a colored male laborer, thirty-one years of age, entered the Lakeside Hospital complaining of sharp shooting pains in both legs, attacks of cramp-like pains in his abdomen, difficulty in walking, attacks of numbness of both legs, frequency of urination and impotence.

In July, 1923, he was accidentally shot by a .32 calibre revolver. The bullet entered the left hypochondrium near the mid-clavicular line. At that time an exploratory operation was done at a hospital in Milwaukee, but the bullet was not found. Röntgenograms taken later were said to show the bullet in the lower lumbar region. The patient made an uneventful recovery from that operation and had no further symptoms until the onset of his present illness in December, 1925.

The first attack of sharp shooting pains in his legs came on suddenly while he was resting in a chair. The pains lasted for only a few seconds. About a week later he began to have frequency of urination and difficulty in starting the urinary stream. As these symptoms became worse he began to have nocturia five to seven times each night. In January, 1926, he began to have a progressive loss of sexual power. During the following six months he had four attacks of the pains in his legs. The pains were not brought on by exercise. During the three weeks prior to his admission to this hospital he began to have frequent and severe attacks of cramp-like abdominal pain. These attacks steadily became more frequent and more severe, especially at night. There was no nausea or vomiting. During the interval between these attacks the patient was free from pain.

In 1919, he contracted an "ulcer" on his penis. His family physician gave him pills and two doses of "medicine into his arm" for that disease. Associated with the penile lesion there was a bilateral suppurative inguinal adenitis. He denied ever having had gonorrhœa. He had been married about one year, but his wife had never been pregnant.

The physical examination disclosed a robust young negro, lying on his right side with his thighs flexed on his abdomen, apparently suffering from some severe acute pain. His pupils were slightly irregular in outline but they were equal and reacted promptly to light and accommodation. The external ocular movements were normal. The eye grounds showed slight engorgement of the retinal veins, but there were no hemorrhages or areas of exudate and no evidence of choked discs. The heart was not enlarged, but there was a soft blowing systolic murmur at the apex and along the left border of the sternum. There were no diastolic murmurs. The blood-pressure was 135/85. On the anterior abdominal wall along the mid-clavicular line in the left hypochondrium, there was the scar of the previous operation. At the upper end of this scar there was another irregular scar, evidently the site where the bullet had entered the abdomen. The entire abdomen was soft and non-tender even during the attack of pains. The knee-jerks, Achilles and plantar reflexes were all absent. There were no Babinski or other pathological toe-signs present. The abdominal and cremasteric reflexes were present but very sluggish. There was no disturbance of the sense of heat, cold or pressure in the legs, but there was slight hyperæsthesia over the posterior aspect of both thighs. This



disturbance in sensation was not constant. The gait was unsteady. The Romberg test was questionably positive. There was moderate ataxia of both legs by the heel to knee test, but there was no ataxia of the arms.

Laboratory tests showed his urine to be normal on several occasions. He had 4,940,000 erythrocytes and a white blood-cell count of 7800. His blood Wassermann reaction was negative on two occasions.

Lumbar puncture yielded clear, colorless cerebro-spinal fluid under slightly increased pressure. The test for globulin was negative. There were four mononuclear leucocytes per cubic millimetre of fluid. The spinal fluid Wassermann reaction was negative. The Lange gold sol curve was normal. Three days later the lumbar puncture was repeated and the same negative results were obtained by various tests. Smears of the prostatic fluid were normal. No gonococci were found.

*Röntgenologic Reports.*  
—August 2, 1926. Films of the lumbo-sacral region in the antero-posterior position show a metallic foreign body the shape of a bullet, at the level of the first sacral spinous process in the midline.

August 28, 1926. Fluoroscopic examination of the lumbar vertebrae, with the patient in various positions, shows the metallic foreign body at the level of the lower border of the fourth lumbar vertebra just posterior to the body of that vertebra and apparently anterior to the spinal cord.

August 30, 1926. Stereoscopic films of the lumbar spine, taken with the patient in the supine position, show the bullet at the level of the first sacral spinous process and apparently in the spinal canal. Films of the lumbo-sacral spine in the postero-anterior and lateral positions, with the patient's pubic region elevated, show the bullet at the lower border of the third lumbar vertebra.

The changes in the position of the bullet, with the patient in different positions, is to be explained by the fact that the bullet is freely movable in the spinal canal.

*Operations.*—At the time of the first operation at this hospital it was still thought that the bullet, which according to the röntgenograms (Figs. 1 and 2) appeared to be in the soft tissues of the back opposite the fifth lumbar spinous process, was not responsible for the patient's symptoms. In spite of this, however, it was decided to remove the bullet.

At operation the patient was placed on his abdomen and given gas-oxygen-ether anaesthesia. An incision was made just to the right of the spinous processes, extending

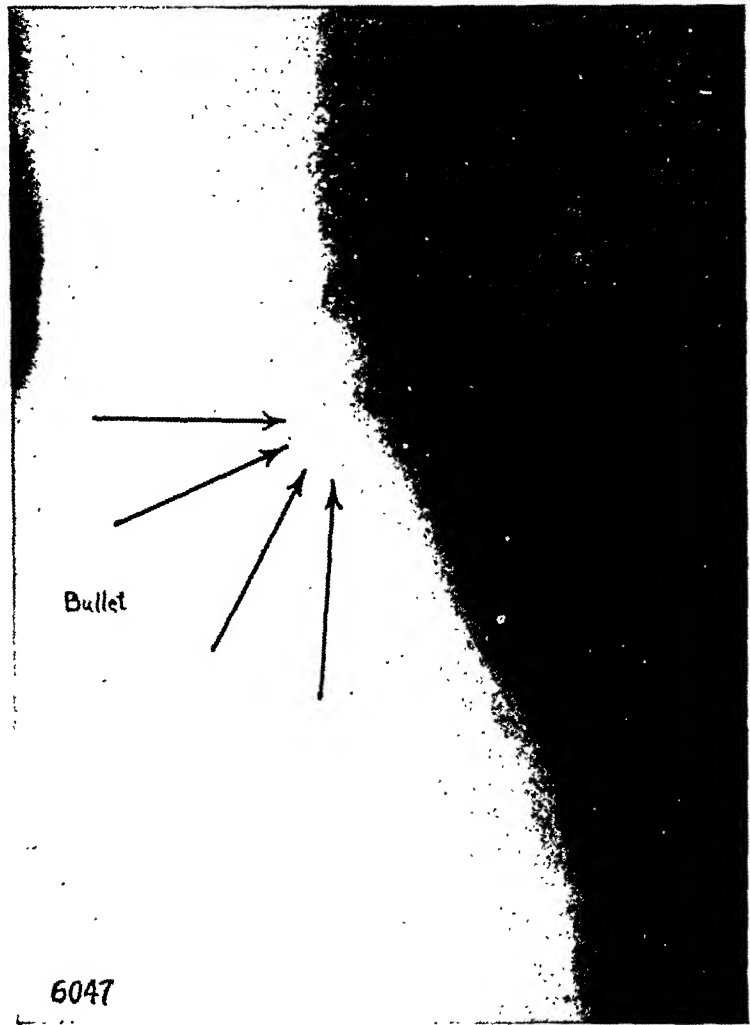


FIG. 2.—Röntgenogram with the patient in the lateral position. Arrows point to the site of the bullet.

from the fourth lumbar vertebra to the mid-portion of the sacrum. A very careful search of this area on both sides of the spinous processes was then made but no evidence of the presence of a foreign body could be detected. A röntgenogram taken at this time showed the bullet at the lower border of the third lumbar vertebra (Fig. 3), which was much higher than the previous röntgenograms had shown it. The full significance of this shift in the position of the bullet was not appreciated at this time. The shift was attributed to the fact that the previous röntgenograms were taken in the antero-posterior position while the reverse conditions were present when the latter röntgenogram was taken.

Since there was no evidence of a foreign body in this region outside of the spinal canal, a laminectomy was done. The laminae of the fourth and fifth lumbar and the first sacral vertebrae were removed. The dura appeared normal throughout. Careful extradural search revealed no evidence of a foreign body. Palpation of the dura in the region exposed likewise gave no evidence of the presence of a foreign body within the dural sac. Röntgenograms were repeated, and again the bullet was shown at the level of the third lumbar vertebra. Due to the patient's condition it was thought unwise to subject him to any further exploration at this time. The wound was closed.

After the wound of the preceding operation had entirely healed, further röntgenologic studies were made. These studies consisted of stereoscopic röntgenograms and fluoroscopic examinations which definitely showed that the bullet was freely movable in the spinal canal.

Seven days after the laminectomy the wound of the previous operation was opened under novocaine anesthesia by Dr. Claude S. Beck. This time the patient was placed in a similar position on his abdomen except that his head and shoulders were elevated by means of several pillows. The dura mater was again exposed but this time was incised. About a hundred cubic centimetres of clear, colorless cerebro-spinal fluid escaped. Soon after this loss of cerebro-spinal fluid the patient complained of very severe occipital headache. The bullet, which was free in the sub-arachnoid space, presented itself at the opening in the dura at a point opposite the middle of the fifth lumbar vertebra. In an attempt to grasp it with a forceps it readily moved upward. The patient's head was raised slightly and the bullet again presented itself in the operative field so that it could easily be removed without injuring the roots of the cauda equina. The bullet was a .32 calibre copper-jacketed revolver bullet. The opening in the dura was closed with interrupted sutures of silk. The rest of the wound was closed in layers by means of silk sutures. At the end of the operation the patient's condition was good in spite of the fact that he was suffering from a very severe occipital headache.

The patient made an uneventful recovery with a complete disappearance of all his former symptoms. During the past year he has been seen and examined at regular intervals and at no time has he had any recurrence of his former symptoms. There has been a gradual return of his sexual ability. His knee-jerks and Achilles reflexes are still very sluggish, but at present no other neurological disturbances can be demonstrated.

*Discussion.*—After reviewing the cases already reported, it is fair to conclude that the presence of a foreign body in the spinal canal is of grave significance. Hughes,<sup>10</sup> in his conclusions based on five cases where the missile lay in the spinal canal, states that opening the dura admits such a great additional risk that the indications must be very definite to justify it. His experience, as well as the experience of Guillain and Barré,<sup>11</sup> tends to show that in the cases which recover from injuries of the spinal cord, caused by bullets, the spicule of bone from the fractured vertebra, or the bullet, does not penetrate into the sub-arachnoid space but causes the symptoms by pressure on the cord from outside of the dura mater. This, however, has not

been true in the majority of the cases reported in the literature nor in the results in our own case. Hull<sup>7</sup> cautions about the early removal of foreign bodies from within the dura because of the dangers of infection of the spinal meninges. He advocates allowing sufficient time to elapse in order that the individual may overcome any low grade infection in the wound.

The violent headaches which follow such an operation as opening the dura mater may be a rather serious complication. The severity of the headache can sometimes be lessened by placing the patient flatly on the back and elevating the foot of the bed. Hypodermoclysis and external heat may also be of some benefit. Weed and McKibben,<sup>13</sup> Leriche<sup>14</sup> and others advocate the use of intravenous injections of distilled water in doses of forty cubic centimetres in all cases where there has been a marked loss of cerebrospinal fluid. This is usually effective in diminishing the severity of the headache even when it is of such an intensity that complete abolition is practically impossible.

In any case of a foreign body in the region of the spinal column it is very important to have the röntgenograms taken with the patient in various positions. Fluoroscopic examinations, as well as stereoscopic röntgenograms, of doubtful cases are usually of great help in making an accurate localization of a foreign body. It has been the experience of those who have reported similar cases, that, unless careful röntgenologic studies have been made before the first operation, the attempt to find the foreign body may be unsuccessful.

It is difficult, in the case reported here, to explain the sudden onset of the severe paroxysms of pain. Probably the bullet had been held by one of the spinal nerve roots or by a reflection of the spinal meninges and suddenly became dislodged in such a way as to remain free in the sub-arachnoid space.



FIG. 3.—Röntgenogram taken at the time of the first operation. The bullet is shown at the lower border of the third lumbar vertebra.

Its subsequent movement in the sub-arachnoid space would cause irritation to the roots of the cauda equina and in that way produce the severe paroxysms of pain. The patient was unable to associate the onset of the initial attack of pain with any sudden trauma.

#### SUMMARY AND CONCLUSIONS

1. A foreign body free in the spinal canal is rarely seen.
2. The symptoms caused by a foreign body free in the spinal canal may closely resemble those usually seen in tabetic crises.
3. The majority of cases that have been reported have been subjected to more than one operation because the foreign body was not at the point originally localized by the Röntgen-ray examination.
4. Elevation of the patient's head and shoulders may be sufficient to bring the movable foreign body into the operative field.

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# THE END RESULT IN ALBEE'S OPERATION FOR SPLINTING VERTEBRÆ

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THE accidental discovery of an old Albee splinting of the vertebral column in one of the bodies delivered to us for dissection affords the opportunity of studying the end-result of this operation.

The cadaver is a white male, ca. fifty-five years of age. The cause of death was chronic mania: there is no clinical history. Existing sinuses in right Scarpa's triangle and about the upper right tibia assure us of mixed infections starting with bone tuberculosis. The fused condition of the twelfth thoracic and first lumbar bodies with evidence of old damage through loss of substance with partial collapse of ventral parts suggests strongly a healed tuberculous lesion.

The condition which called for the operation is of no significant interest, except insofar as it might modify the normal healing of bone after surgical interference. That no such modification has occurred is sufficiently obvious and we may therefore dismiss the question which resolves itself into mere academic speculation.

Since there is effective and complete fusion of the articular processes also it may be inquired whether, as might quite likely be the case, a Hibbs' operation has been performed also. There is no indication of mutilation or operative interference in these articular processes and, judging from other cases of vertebral pathology, their fusion need not have been definitely provided for by a kind of erosion of the articular surfaces.

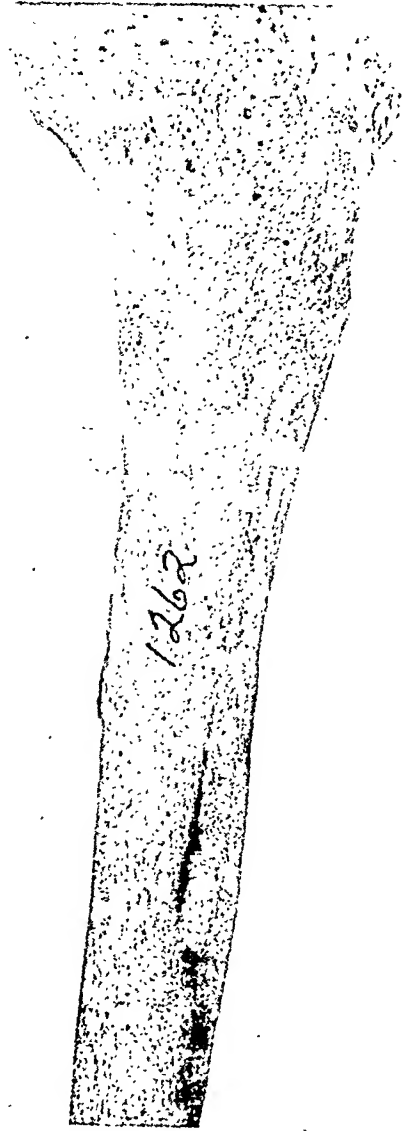


FIG. 1.—Upper left tibia showing source of splint. The area whence the splint was removed, broader below than above, is healed and the excavation almost filled up with new bone.

The figure of the left tibia shows that a splint 117 mm. long and somewhat broader below than above, has been raised from the upper subcutaneous surface. Healing of the tibial wound has taken place perfectly and the trench left by operation in the shaft has practically filled with new bone.

The splint, now 75 mm. long, has been dovetailed into the spinous processes of the twelfth thoracic and first lumbar vertebræ, its broader part above. The narrow end of the splint projects below the spine of the first lumbar but did not reach the spine of the second which was not grooved to receive it. Perfect

healing of the splint in its new environment has resulted in the fusion desired by the operator.

Important light is thrown upon the controversial question whether the splint actually remains or simply acts as a temporary scaffolding for new bone which ultimately replaces it. This is the question which also arises regarding fossils, in which problem the true answer invokes at times one, at times the other of these two replies, and sometimes indeed involves both. Texture is an infallible guide to bone history (see Todd, T. W. and Iler, H. D., "The



FIG. 2.—Dorsal aspect of splinted vertebræ. The splint lies in a groove cut in the spinous processes of the twelfth thoracic and first lumbar vertebræ. Perfect union has taken place between spinous processes and splint and elsewhere the latter presents a typical passive appearance.

Early Phenomena of Repair in Bone," 1927, ANNALS OF SURGERY, vol. lxxxvi, p. 715).

A smooth waxy texture is characteristic of bone which has lost its periosteum, has been largely reduced in its blood supply and hence has lost the power of adding to its substance. Fragments falling into this category frequently occur in compound simple fractures. Their vitality is diminished but not destroyed. They take no active part in regeneration but do contribute their strength and rigidity to the new bony mass in which they find themselves incorporated. Of such texture is this splint where it has been lying surrounded by soft tissues between the two splinted spinous processes and extending downward therefrom. The remarkable thing is that such a bone though becoming a foreign body in the midst of soft tissues, suffers no erosion and is not absorbed though it may be bent as this one is. But above all it does not die: it is merely passive.

## THE END RESULT IN ALBEE'S OPERATION

A quite different result is apparent in the areas of the spinous processes. Here the splint shows traces of an original erosion of surface, rarefaction of adjacent substance and marginal proliferation (external callus), processes which have also involved the neighboring parts of the spines, so that fusion of the splint in place is perfect and the united areas have become quiescent long ago. The original splint has undergone the same transformation in these sites as any active fragment undergoes in the repair of a fracture, neither more nor less. It is quite erroneous to hold that the splint is not permanent and is replaced by new bony issue. But it is equally erroneous to refuse to admit the marked marginal modifications which are inseparable from the repair processes inducing fusion.

### SUMMARY

The case is one of perfect functional result from an Albee's operation uncomplicated by any Hibbs' procedure.

Where the splint is grafted into the spinous processes there has been marginal erosion and proliferation of new bone precisely as in the repair of a fracture.

Where the splint lies embedded in soft tissues no proliferation or change has taken place in the implanted bone, except that a modification of its texture has occurred indicating a living but inactive condition.

Hence both current views are justified regarding the fate of the splint, namely, that it remains unchanged and also that it acts as a temporary scaffolding for the erection upon it of new bone tissue.



FIG. 3.—Right side of splinted vertebræ. Note the union of bodies and articular processes, the bending of the splint and the waxy texture of passive bone.

# CHANGES IN BLOOD CONCENTRATION WITH SPECIAL REFERENCE TO THE TREATMENT OF EXTENSIVE SUPERFICIAL BURNS\*

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AMONG the nutritional requirements of the body that of water holds a prominent place. Normally, the capacity of the organism for storing water is very great. The body usually possesses an available store of water which exists for the most part in the muscles and skin although all tissues undoubtedly share in this function. When for any reason water is withheld or withdrawn from the body the different tissues and organs vary markedly in their water loss. Thus, the fatty tissues, the brain, heart, and bony structures lose relatively little water as compared with the muscles and skin. More than one-half of the water lost is given up by the muscles without apparent injury to either structure or function. The same is probably true for the skin.

On the other hand in water loss the condition in the blood is quite different. It is an axiom in physiology that the composition of the blood is constant. Comprehended in this statement is the recognition of small fluctuations in either direction induced probably by the organism in its attempt to maintain the equilibrium of the circulating medium. Under normal circumstances the stability of blood composition is remarkable. This constancy of blood composition may be regarded as one of the most fundamental requirements of the organism in its endeavor to safeguard the environment of the cell. As proof of the general proposition just cited one has only to think of the constancy of blood sugar content, of the urea of the blood, of uric acid, of the stability of the acid-base equilibrium, and of the small variations in inorganic constituents, as calcium, magnesium, sodium and potassium.

Attention, however, is particularly called to an entirely different aspect of blood composition. Normally, the water content of the blood constitutes one of the body's constants. Attempts to alter the water content of the blood by introduction of even large volumes of fluid have failed to change appreciably blood composition. The water regulating mechanism is adequate to make the proper compensation quickly. It is only when this mechanism is overwhelmed either experimentally or as a result of disease that marked changes in blood concentration occur. Either dilution or concentration effects may then be observed, although, in general, from studies thus far carried through concentration is more commonly encountered than is dilution.

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\* The substance of this communication formed the basis of an address before the New York Section of The American Chemical Society, June 3, 1927.

The literature on the subject of blood concentration has been reviewed under the title of Anhydremia by Marriott W. McKim: *Physiol. Reviews*, 1923, vol. ii, p. 275.



In the blood, concentration to even a moderate degree results in recognizable symptoms. The first indication noted is impairment of the circulation. When water loss becomes great the circulatory deficiency is magnified. The thick, sticky blood finds difficulty in its passage through the capillaries. It becomes an inefficient oxygen carrier, resulting in partial asphyxiation of the tissues. In consequence, there may be alteration in the metabolic processes, and when blood concentration has reached a certain high level a disturbance in the heat-regulating mechanism occurs: the temperature, at first, elevated, falls and vital activities are suspended.

Before discussing further the problem of blood concentration it may not be out of place to consider the question how to measure changes in blood concentration. Of all the constituents of the blood only the red corpuscle fails to pass rapidly through the capillary wall. From this viewpoint it would appear that the measurement of hæmoglobin content should serve as an excellent indicator of changes in blood concentration. This procedure, however, is not entirely free from possible sources of error since in various diseased conditions it is well recognized that hæmoglobin content varies greatly especially over extended periods of time. Moreover, even in short time intervals new corpuscles may be poured into the blood stream or masses of corpuscles may be held in certain restricted areas. Again, "when a condition of severe anhydremia has lasted for a number of days a decrease in the concentration of hæmoglobin and of serum protein occurs even though the body weight and the blood volume determinations may indicate a further loss of water (Lust, Marriott). This may be taken as indication of destruction of blood corpuscles and of serum protein. The experiments of Gürber on frogs, of Utheim on rabbits and Keith on dehydrated dogs shows a decrease in the total number of red blood cells in the circulation, when the diminished total blood volume is considered in connection with the cell counts and protein concentration. As a result of this destruction of the blood constituents an abnormally low cell count, hæmoglobin and serum protein contents of the blood are often observed following a restoration of the blood volume of fluid administration. It is thus seen that determination of the cell count, hæmoglobin or serum protein may at times fail to indicate accurately the degree of anhydremia. The same may be said of the determination of total solids. The measurement of blood volume taken together with the determination of the other constituents mentioned supplies the necessary data for the estimation of the degree of anhydremia."

On the other hand, where it is desired to follow changes in blood concentration at frequent intervals the usual blood volume methods are inadequate or too cumbersome to fulfill the experimental conditions. A consideration of this problem over a period of years has convinced the writer that for the purpose of observing blood concentration changes during short intervals of time the hæmoglobin method is unsurpassed by any other method yet proposed, provided experimental conditions are adequately controlled, that small fluctua-

tions are disregarded, and that due consideration is given to possible changes in the number of red corpuscles.

Clinically, severe blood concentration may be encountered when water is refused for prolonged periods as exemplified in cases of mental derangement. Individuals exposed to the high heat of the desert or subjected to the heat of boiler rooms or mines (Haldane) often show marked blood concentration. Vomiting induced by any cause may be productive of severe blood concentration. This is especially true for infants with pyloric stenosis since little water is absorbed from the stomach and relatively little reaches below the pylorus. High intestinal obstruction leads to the same result.

In persistent diarrhoea much water may be lost to the organism through the stools. In Asiatic Cholera and certain forms of diarrhoeas in infants such loss is peculiarly marked and may be productive of blood concentration to a degree sufficient to lead to death. In infants especially severe blood concentration is likely to occur, partly, from the fact that they have a high water requirement which may not be covered since they are dependent upon others for their water supply, and, partly, for the reason that infection may induce refusal of food, vomiting and diarrhoea with a subsequent concentration of the blood. In cases of infantile toxemias, so-called, it is generally exceedingly difficult to determine whether concentrated blood initiates the clinical symptoms or whether concentrated blood must be regarded as secondary to some other change in metabolic processes. Certain it is, however, that in many of these cases if blood concentration can be restored to the normal level the condition of the infant is usually greatly improved and soon regains the normal state.

It is well recognized that in war gas poisoning the outstanding feature of the pathological state is the markedly concentrated blood. In certain fulminating cases of influenza a similar condition is presented and in extensive superficial burns concentrated blood may be chiefly responsible for the clinical symptoms evoked. In eclampsia and in surgical shock the blood is generally concentrated above the normal level.

Experimentally a concentrated blood may be induced by restriction of water intake, by sweating, by the action of certain drugs, as pilocarpine, cantharides, saline cathartics, by proteose, histamine, by administration of sodium chloride or urea by mouth or by the intravenous injection of sodium chloride, urea, glucose, saccharose or lactose.

The composition of the blood when highly concentrated shows various changes such as increased viscosity, and the non-protein nitrogen is generally augmented which may be explained in part by the functional disturbance of the kidney induced by the dehydrated blood and in part by an increased destruction of protein. Sugar of the blood may also be above normal. This finding is a common occurrence in other conditions associated with a lowered blood volume as in shock (Cannon). It may also be induced under a variety of circumstances in which there is vaso-constriction or a diminution in the oxygen-carrying capacity of the blood (Araki). Acidosis, as indicated by

diminished alkali reserve, carbon dioxide content and bicarbonate combining power, is a prominent feature of a highly concentrated blood, which, however, rapidly disappears when the blood volume is restored to the normal level. Acidosis therefore must be regarded as a secondary manifestation induced without doubt by the failure of the circulation. When the kidneys are affected acid phosphates may be retained which is undoubtedly an additional factor in the production of acidosis.

With a highly concentrated blood there may be evidence of a distinctly impaired functional capacity of the kidney. The kidney only occasionally shows structural changes. All evidence of renal impairment disappears with the restoration of a normal water balance. This fact leads to the conclusion that the renal insufficiency is purely functional, probably the result of the inability of the kidney to separate a normal urine from a concentrated blood.

The blood pressure may be high or low; usually, however, it is well maintained. In shock, of course, and in Asiatic Cholera it may be very low. One reason why dehydration of the blood does not cause a significant fall of pressure is perhaps because the increased viscosity prevents that condition which might be expected to occur with a decreased blood volume.

In most of the published discussions relative to changes in blood concentration apparently little attempt has been made to differentiate these changes and correlate them with the types of reactions calling them forth. For example, in conditions of clinical anhydremia no distinction is made between the state existing in water starvation and that induced by extensive superficial burns and yet there must be a vast difference in the significance to be attached to the two conditions. This is especially prominent when attempts are made to restore the blood to a normal level of concentration. In the case of anhydremia induced by water deprivation simple administration of water rapidly restores the blood to its normal condition whereas in anhydremia from superficial burns the restoration to normal is much more difficult. It would appear that in the two examples cited fundamental differences exist in the mechanism leading to the anhydremia. There are at least two ways in which blood concentration may be induced. In the first place one may imagine that a fluid, nearly simple water, or a dilute salt solution, in composition, leaves the blood-vessels in response to the proper stimulus, resulting in a more concentrated blood, a dehydration, a desiccation as it were. Or again by a different type of mechanism, or perhaps as a result of a different form of stimulus, fluid of the nature of dilute plasma rather than of salt solution passes through the vessels leaving behind a blood concentrated above normal. That both these two types of change occur will be pointed out later.

The impetus for our own studies in changes in blood concentration came from experience with war gas poisoning in which it was shown that the intensive irritation of the respiratory tract by the gas called forth a massive œdema which is associated with very marked blood concentration. The intensity of blood concentration under these circumstances became so great that the heart was unable to push the thick viscid blood through the capillaries at a rate

sufficient to aerate properly the tissues, resulting eventually in tissue asphyxiation, fall of temperature, circulatory failure, and death. Death was ascribed to the change in blood concentration rather than to pulmonary oedema. From a wide experience the impression was gained that within certain well defined limits concentrated blood, although not compatible with proper nutrition, is not necessarily a serious condition. Beyond these limits, however, life can be maintained for only a short interval. To put it differently—blood concentration up to 125 per cent. of the normal value is not serious but when 140 per cent. has been reached danger enters and life is not possible for long if this limit is maintained. These relatively wide variations which may occur without serious consequences may be regarded as another example of the factors of safety resident in the organism. That death is due to blood concentration rather than to pulmonary oedema can be tested experimentally by gassing two animals with the same concentration of gas for equal periods of time. Both animals will develop pulmonary oedema to the same degree and both will present the same blood concentration picture. If one is treated so as to maintain blood concentration below the danger level recovery will follow, whereas the untreated animal will die. In neither case does the treatment materially change the lung condition, at least during the critical period.

Another striking example of this type of blood change is seen in certain cases of influenza, the alteration of concentration of the blood being invariably associated with a fatal outcome. From the standpoint of pathology these cases of influenza present a lung picture difficulty distinguishable from that of gas poisoning. From these two facts, together with the similarity in the manner of death, one may be perhaps warranted in concluding that the mechanism called into play in the two instances is either the same or else closely related.

It seems a far cry from gas poisoning and influenza to superficial burns and yet in the latter instance the blood may be markedly concentrated and if sufficiently so undoubtedly plays a large contributing rôle to a fatal outcome. The proof for this statement lies in the fact that if by any means blood concentration can be prevented or abolished the chances of recovery in any of the conditions cited are very materially increased.

Our experience with the treatment of the systemic effects of superficial burns was gained as a result of observations carried through on more than twenty victims of a theatre fire in New Haven.

The patients were admitted into the New Haven Hospital † in the early evening and at once received first aid treatment and were sent to the various wards. Blood concentration estimations were made at once. From the clinical standpoint the patients were divided into two groups (*a*) those seriously burned (*b*) those not so seriously burned. The blood concentration of the first group was above the danger level, namely, more than 125 per cent. Those

† Through the courtesy of Dr. Samuel C. Harvey, Surgeon-in-Chief in the New Haven Hospital, opportunity was afforded to us to conduct this investigation. (The details of the work are published in the Archives of Internal Medicine, 1923, vol. xxxii, p. 31.)

less seriously burned were below this level. The correspondence between the severity of the clinical picture and the blood concentration was perfect. In the first group all patients were placed upon the danger list, in the second none were included in this list. The first point of significance in this investigation is that the determination of blood concentration which takes only a few moments serves as an indication of the gravity of the patients' condition and also points out definitely the type of treatment necessary.

In our opinion the serious condition in burn cases is the concentration of the blood and treatment should be directed to reduce this concentrated blood to a more fluid state. The systematic treatment of these burn cases consisted simply in the forcing of fluids, water by mouth when possible, when the patient could not coöperate because of unconsciousness, fluid was injected under the skin, directly into the blood, by the rectum, etc. The quantity of fluid taken in varied from four to eight litres daily.

In a day or two on this treatment the blood concentration fell gradually and the patients' condition steadily improved. All patients so treated recovered although of the group of those severely burned the vast majority could be regarded as poor risks.

"Although from figures and other data relative to these observations one is apparently justified in concluding that restoration of blood concentration is of prime significance in burn cases, nevertheless, to the sceptically inclined there are at least two points at which the above conclusions may be attacked. In the first place, one may assume that fluid intake has only an inappreciable influence on blood concentration, that fluid is excreted from the body almost as rapidly as it is ingested. All the available literature on the subject supports such an assumption. One point, however, must be emphasized, namely, that in nearly all instances in which this hypothesis has been put to the test the organism employed was that of a normal person. Herein lies the crux of the whole matter. It is utterly fallacious to predict the behavior toward water administration of an organism suffering from lack of water from observations made on an organism with a sufficiency of water supply. It is quite true that partaking of large volumes of water by normal man or dog does not perceptibly alter the concentration of the blood. So long as the water regulating mechanism of the body is normal such a result is to be expected. On the other hand, when an animal has been deprived of water for a sufficiently long period, blood concentration becomes markedly increased. Water administered under these circumstances causes a rapid fall in the concentration of the blood. The experiments by Keith and by Underhill and Kapsinow cause us to reiterate the statement previously made that it is fallacious to draw conclusions relative to the abnormal organism when these inferences are largely based on observations on normal persons, and they furthermore dispose of one of the points of attack cited above.

A second point of attack centres in the query, "Did the fluid intake in these cases actually influence blood concentration or would blood concentration have returned to the normal without such aid?" To answer this question

absolutely control experiments would be necessary. Such a control, however, is obviously lacking. The question receives a partial answer from the experiments of Keith and our own cited above together with our experience with war gas poisoning. Death may follow, but blood concentration is not restored to near normal limits under conditions of water lack unless sufficient fluid has been introduced. We believe, however, that the question is fully answered by our experience with one burned patient treated outside the hospital. A victim of the same fire, this patient was cared for at his home by his own physician. Special attention to forcing of fluids was lacking. This case was especially badly burned and presented the typical signs and symptoms characteristic of intoxication from burns, chief among which was an active delirium, it being necessary to take measures to keep the patient in bed. This was succeeded by a period of collapse and unconsciousness, death being anticipated. After a period of eight days, consultation with the physician resulted in the active forcing of fluids. Previous to fluid administration (two litres of 0.7 per cent. sodium chloride solution subcutaneously) the hæmoglobin value was 163 per cent. A few hours after the salt solution had been given the patient regained consciousness, became rational, and was capable of coöperation in taking of fluid. Blood concentration fell rapidly and the patient went on to recovery. The point to be emphasized here is that this patient on the eighth day after being burned still had a blood concentration equal to that in some of our own serious cases on the first day. The presumption is valid that if this patient's blood concentration would have returned to normal of itself it should have done so within a period of eight days, an interval during which none of our own treated patients maintained such a concentration.

From such data it would appear that water intake is responsible for the decrease in blood concentration observed in our cases, and it is quite safe to assert that without such water introduction blood concentration would not have taken the decided fall observed in every case. We believe, therefore, that the observations recorded justify the conclusion that water introduction in sufficient quantities to restore blood concentration to within normal limits is of paramount importance in the treatment of burned cases. As a result of this type of treatment, it may be stated that only two patients gave any evidences of symptoms characteristic of intoxication in burns. In these cases unconsciousness at first prevailed; this, however, disappeared after restoration of the normal blood concentration. In all the other cases, the patients presented no untoward symptoms, such as delirium, unconsciousness, gastro-intestinal disturbance, hæmoglobinuria, albuminuria, etc. Whether such facts are to be interpreted from the viewpoint that restoration of blood concentration prevented the development of conditions responsible for these symptoms or that fluid introduction caused prompt elimination of toxic material so diluted as to be innocuous or both, remains a problem the solution of which can be determined only in the future. At any rate, from either viewpoint it would appear that fluid introduction is a rational method of treatment for extensive superficial burns."

## BLOOD CONCENTRATION IN SUPERFICIAL BURNS

Since the initial experience gained from the victims of the theatre fire we have had occasion to treat a number of burned cases in the New Haven Hospital and have been consulted on cases in various parts of the United States and in general the results obtained from the treatment have been very encouraging.

How is it that the same type of mechanism is called into play in two such diverse pathological conditions as war gas poisoning and superficial burns? A little thought will show that the difference is apparent rather than real—the seat of action is the factor which makes the apparent diversity.

In a consideration of the development of pulmonary œdema in gas poisoning I wrote the following—"the lethal war gases are all substances eminently irritant to living tissues and it must be accepted that the irritation produced by a gas is the initial step in the development of œdema. In response to the first irritative stimulus tissue fluid finds its way to the injured area in an apparent attempt toward repair or alleviation of the injury. It is conceivable that if damage to the tissue is only slight such a procedure would result in the passage to the damaged area of only a small quantity of tissue fluid. According to this view the degree of response with respect to the local deposition of tissue fluid would be in direct ratio to the extent of injury. On the other hand, it is equally plausible to assume that this reaction may reach a breaking point at a certain degree of stimulation whereby the whole mechanism governing the exudation of tissue fluid is thrown out of control so that the response to the stimulation becomes overwhelming. Under these conditions a reaction which in its initial function may be regarded as beneficent eventually becomes a direct menace to continued existence on the part of the mechanism as a whole, merely by interposing difficulties in the way of respiration and circulation." If in this quotation one substituted for war gases, heat as the irritative stimulus playing upon the skin the mechanism is entirely similar. With burns, fluid rushes to the skin, resulting, if the skin is unbroken, in either œdema of the part affected or blisters; or if the burn is more severe fluid drips from the raw surfaces. Our experience in burned cases leads one to believe that the quantity of fluid lost in this way during the first few hours after the injury may be very large, in fact sufficiently great to account for the rapid blood concentration which occurs.

Other abnormal conditions which produce a marked concentration of the blood are Asiatic Cholera; shock, whether arising spontaneously from trauma or toxemia, or evoked experimentally by peptone or histamine; dysentery; acute arsenic poisoning and peritonitis.

If one analyzes these pathological states it must be quite evident, that the one underlying factor common to all with the exception of shock, is that an extensive inflammatory reaction is prominent, acting usually upon a more or less restricted area, as the respiratory tract, the skin, the alimentary canal, the peritoneum, etc. All are areas plentifully supplied with capillaries.

In order to understand the nature of the mechanism producing the blood concentration a word as to the character of the fluid lost from the blood is



essential. From my own observations on gas poisoning it becomes apparent that this fluid partakes of the nature of plasma, diluted plasma, as it were, containing somewhat less protein than plasma, but otherwise of practically the same composition. The fact that significant quantities of proteins are present and indeed the blood proteins, particularly fibrinogen, leads to the view that the irritant factor has changed the character of the capillary wall. In ultimate analysis therefore one may conclude that the direct cause of blood concentration, in the pathological states under discussion, is due to a changed permeability of the capillary wall.

In most of these instances actual loss of fluid to the body has occurred sufficient in amount to account for the concentration of the blood. With shock, however, where no loss of fluid to the body takes place the explanation of the mechanism is not so obvious. Under shock conditions increased capillary permeability may also explain the mechanism involved since the fluid leaving the vessels is plasma (Bayliss, Dale). The toxic substance responsible for the condition acts more or less specifically upon the capillaries resulting in a pouring of fluid into the tissue spaces of the body, thus provoking an exceedingly rapid and marked blood concentration.

From our experience and conception of the mechanism involved in the loss of plasma from the blood a change in capillary permeability is essential—in the loss of salt solution no such alteration is necessary. We believe that any irritative or inflammatory reaction upon any extensive area of mucous membrane may, if sufficiently acute, cause a rapid loss of plasma resulting in blood concentration. In general it is this type of blood concentration which is likely to prove disastrous to the organism. We shall return to this point later.

Blood concentration induced by loss of water and presumably salts only, results in a concentration by a process of dehydration or real desiccation. This is what occurs when sufficient fluid is not introduced as by experimental water deprivation of animals, or clinically in the dehydration of infants. Again intense secretion induced by pilocarpine or purgation by the saline cathartics will cause a rapid blood concentration. It is significant, however, that this process in general does not proceed to the point where a dangerous degree of blood concentration is attained. The concentration approaches the danger line but is not maintained. This, however, is only a general statement and is particularly applicable to the saline cathartics and to pilocarpine. If actual water deprivation is pushed for a sufficiently long period blood concentration steadily mounts and death follows. Such a result, however, can be called forth only by drastic measures.

Blood concentration of this type is obviously of an entirely different nature than that induced by an inflammatory reaction. This becomes quite apparent when attempts are made to restore the blood to its normal concentration. In the former case administration of fluid is all that is essential. With the concentration induced by an inflammatory reaction administration of fluid alone although helpful is not strikingly successful. Why? Because in the latter instance the capillary wall has been modified so that it is no longer



## BLOOD CONCENTRATION IN SUPERFICIAL BURNS

capable to the normal extent of retaining fluid. In other words, in the one type of blood concentration the capillary wall is involved, in the other it is not, at least to an extent capable of measurement.

The potency of the agencies which may play upon the mechanism governing blood concentration are determined in large measure by the fluid content of the body at a given moment. Thus, when an animal has been deprived of water to the point where blood concentration becomes significant even though still within safe limits, the saline purgatives no longer cause purgation. With sodium sulphate and Rochelle Salts no immediate symptoms are in evidence. When magnesium sulphate is employed complete anæsthesia takes place and unless treatment is given immediately death follows. This fact may have a certain clinical bearing in the indiscriminate use of Epsom Salts both before and after operation. The administration of plenty of fluid both before and after operations is in most instances a wise procedure. From this viewpoint if a cathartic is to be used it should be one which by its action does not draw fluid from the blood.

It is also quite probable that shock may be much more easily produced in an organism in which the blood is concentrated than in one when the fluid reserves are normal, for in peptone shock the blood concentration curve is distinctly modified and the poison appears to be more potent.

Another point of considerable clinical significance is the fact that it is much easier to prevent marked blood concentration than it is to change it once it has become established. For the prevention of blood concentration large volumes of fluid are essential administered more or less continuously. In certain instances venesection tends to keep down concentration acting as it were as a stimulus upon the reserves of the body to maintain constancy of blood concentration. In attempts of the past to maintain blood concentration the error in procedure has been that only a single intravenous infusion has been made or repeated infusions at infrequent intervals. The relief afforded has been only temporary since the fluid quickly left the vessels. Administration of fluid should be more or less continuous and it is essential only to attempt to reduce the concentration to the safe limits. This reduction of concentration by administration of fluid or by venesection plus fluid need be practiced for relatively short periods only—it carries the individual over a critical period—a period necessary for restoration of the normal permeability of the capillary wall—in other words the capillary wall repairs itself which takes from twenty-four to forty-eight hours. It is during this period that fluid must be pushed continuously.

In the treatment of burns, therefore, the essential object is to keep the blood concentration near a normal level until the blood capillaries in the skin injured by the heat have had an opportunity to repair themselves and again become capable of holding within themselves the fluid of the blood in a normal manner.

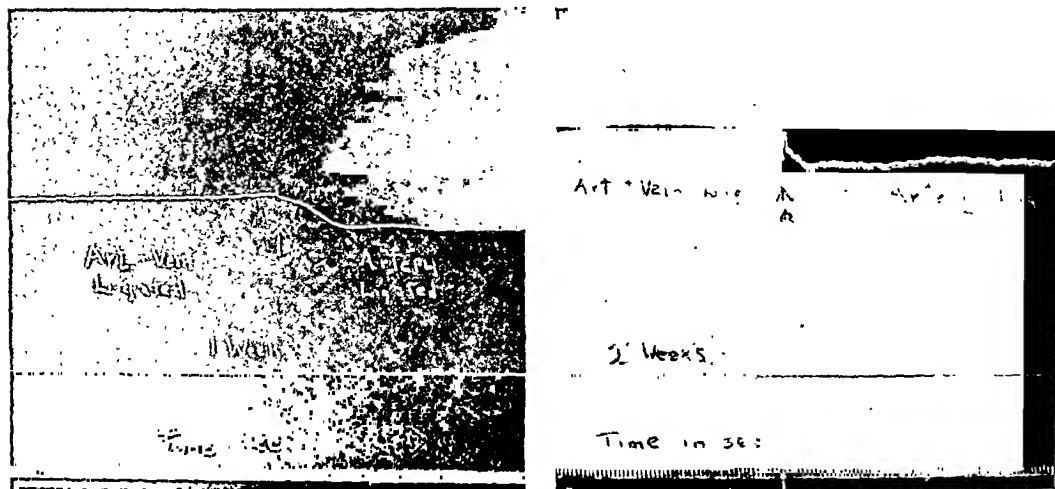
# A NEW EXPLANATION OF THE IMPROVED RESULTS FOLLOWING LIGATION OF BOTH ARTERY AND VEIN

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WITHIN the last ten years the point of view regarding operations for arterial ligation has changed. Formerly all operative procedures were directed to preservation of the accompanying vein. This was done not only to avoid



hemorrhage preserve the lation intact. the experience War it was was an erron- and that si- ligation of vein should be procedure was Sehrt<sup>10</sup> and Germany, Kend<sup>7</sup> in Makins<sup>8</sup> in due to the Makins that

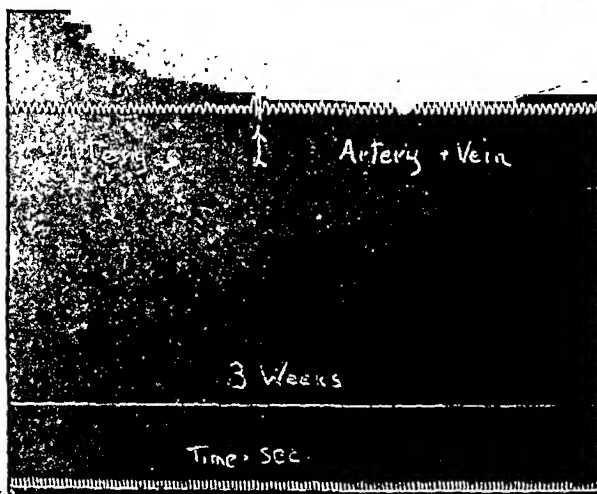


FIG. 1.—The difference in residuary blood pressure in animals having the femoral artery and the femoral artery and vein ligated. A. One week after operation. B. Two weeks after operation. C. Three weeks after operation.

but also to venous circu- As a result of in the World held that this eous opinion multaneous artery and done. This suggested by Propping<sup>9</sup> in Tuffier<sup>11</sup> and France, and England. It is efforts of this principle

has become so well founded. The investigations of Halsted,<sup>3</sup> Brooks,<sup>1</sup> Holman,<sup>6</sup> Heidrich,<sup>4</sup> and Drummond<sup>2</sup> substantiate the contention that balancing the circulation is desirable. Thus, there is both clinical and experimental proof of the fact that simultaneous ligation of an artery and its companion vein diminishes gangrene and improves function. The

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explanation of this phenomenon is not clear. Kend<sup>7</sup> first showed that the residuary arterial blood pressure is elevated by ligation of the vein. This has been confirmed by subsequent investigators. Brooks<sup>1</sup> observed that the temperature of the extremity falls at the time of ligation of the vein. He also demonstrated a greater increase in venous pressure than in arterial pressure and interprets these

findings to mean a diminution in the volume flow of blood through the extremity. Holman,<sup>6</sup> on the other hand, by direct methods, found that the volume flow after arterial ligation was doubled by ligation of the vein at the same level. It is to be noted that these findings have been obtained only in sacrifice experiments of a few hours' duration. The vagaries of small fluctuations in blood pressure are well known. It appears that these explanations alone are insufficient. It was considered that, since gangrene and functional disability are sequellæ of the operation, it was not proper to explain their absence on results obtained at the time of

the operative procedure. Consequently, animals were operated upon and allowed to survive so that at intervals they might be studied. It was found that the elevation in residuary blood pressure and increase in blood flow were but transient phenomena and that perhaps the fundamental cause of the diminished gangrene and improved function after ligation of artery and vein was marked increase in the arterial vascular bed.

*Method.*—Adult cats were used. Under ether anæsthesia a low midline skin incision, extending 1 cm. below the symphysis pubis was made. By lateral traction the femoral vessels were exposed. If it was desired to ligate the common iliac vein the rectus muscle was split, but the peritoneum was not opened. By blunt dissection the peritoneum was lifted up, from the lateral

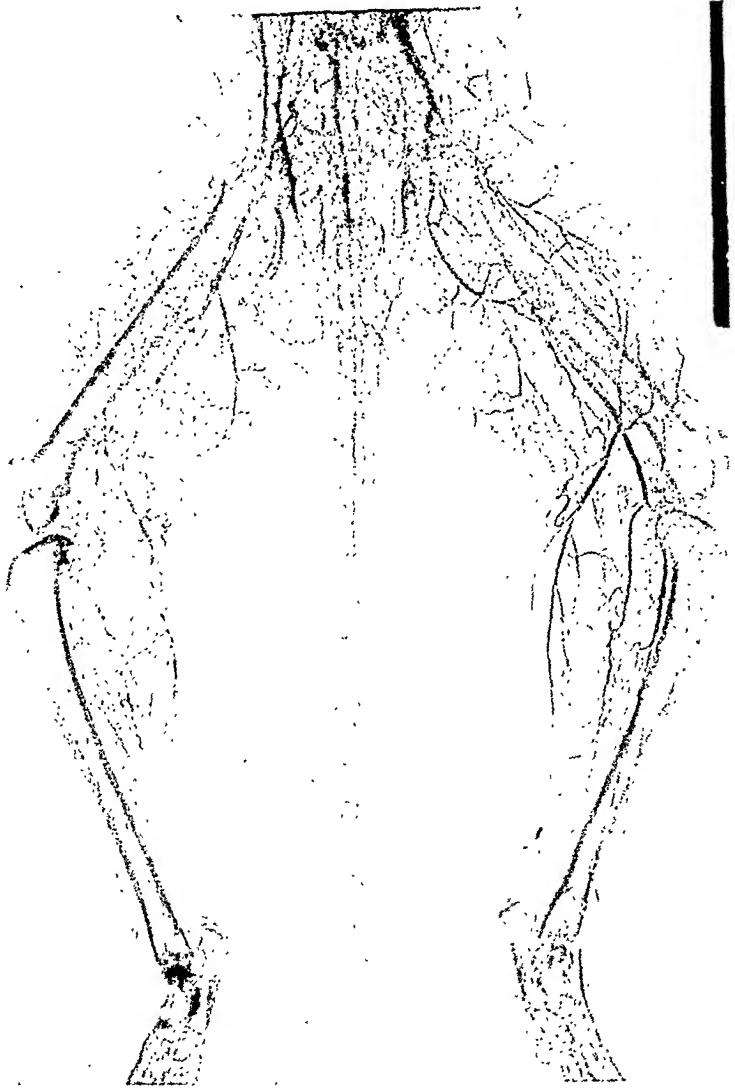


FIG. 2.—The vascular bed two weeks after ligation of the artery and vein (on the side with the marker) compared with that after ligation of the artery alone.

wall of the pelvis and the common iliac vein exposed by this extra-peritoneal method. All experiments were done under conditions of surgical asepsis and the animals permitted to survive.

The operative procedure was of three types :

(1) The femoral artery and femoral artery and vein of the opposite side, were all ligated at the same level.

(2) Both femoral arteries were ligated and the common iliac vein of one side was occluded.

(3) The femoral artery and vein of one side were ligated. On the opposite side the femoral artery and the common iliac vein were tied.

This allows comparison in an animal of the effect of

(1) Ligation of artery and vein versus artery alone.

(2) Ligation of the vein proximal to the site of ligation of the artery, according to Holman's <sup>6</sup> principle, versus ligation of the artery alone.

(3) Ligation according to Holman's procedure, versus ligation of the artery and vein at the same level.

At intervals of one to three weeks after operation the animals were studied.

When the blood pressure and minute volume flow were to be compared after different operative procedures, they were always obtained from the femoral arteries of the same animal. The apparatus was arranged so that readings could be made on either side by merely turning a valve. These results obtained with cats were verified on dogs to assure the corrections of the findings.

The circulatory bed was visualized by röntgenograms after arterial injection with Hill's <sup>5</sup> opaque mass.

*Results.*—The average increase in residuary arterial pressure caused by ligation of the vein is 11 mm. Hg. If the pressure is obtained one week after ligation the average increase is found to be 8 mm. Hg. In two weeks the difference is less marked and was never more than 4 mm. Hg. In some of the animals tested two weeks after operation the pressures on the two sides had completely equalized. At the end of three weeks there was no instance of a difference in arterial pressure after ligation of vein and artery, as compared with occlusion of the artery alone. Typical tracings of these results are shown in Fig. 1. Ligation of the vein proximal to the site of ligation of the artery results in a more marked elevation of the residuary pressure, but even after this procedure the pressures have equalized in three weeks. Arterial pressures were not observed in those animals in which Holman's procedure was compared with the older method of ligation at the same level.

The arterial tree in the operated extremities was visualized by röntgenograms taken one, two, or three weeks after operation. The maximum change was usually obtained at the end of two weeks. It was found that the vascular bed in the limb having artery and vein ligated was much richer than in the limb having only the artery occluded. This is shown in Fig. 2. Holman has advocated ligation of the vein proximal to the point of ligation of the artery since he has found that this gives better results. From the experiments here

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presented it was considered that this procedure resulted in a better vascular bed than did ligation of the artery and vein at the same level. In order to eliminate individual variations the two methods were compared on the limbs of the same animal. In every instance it was found that the circulatory bed was increased on the side having a proximal ligation of the vein. This is illustrated by Fig. 3 where it will be seen that, though the contrast is not marked yet, an apparent difference is present.

*Discussion.*—The present investigation has demonstrated that the increase in residuary arterial blood pressure following ligation of the companion vein is only a transient phenomenon. It is greatest at the time of operation. At the end of one week it has diminished, but there is present a well marked difference in the limb having both artery and vein occluded. In two weeks the difference between the limbs is less or may be absent. Finally by the end of three weeks pressures on two sides have equalized. It was considered that the minute volume flow of blood from divided artery fluctuated directly with the arterial blood pressure.

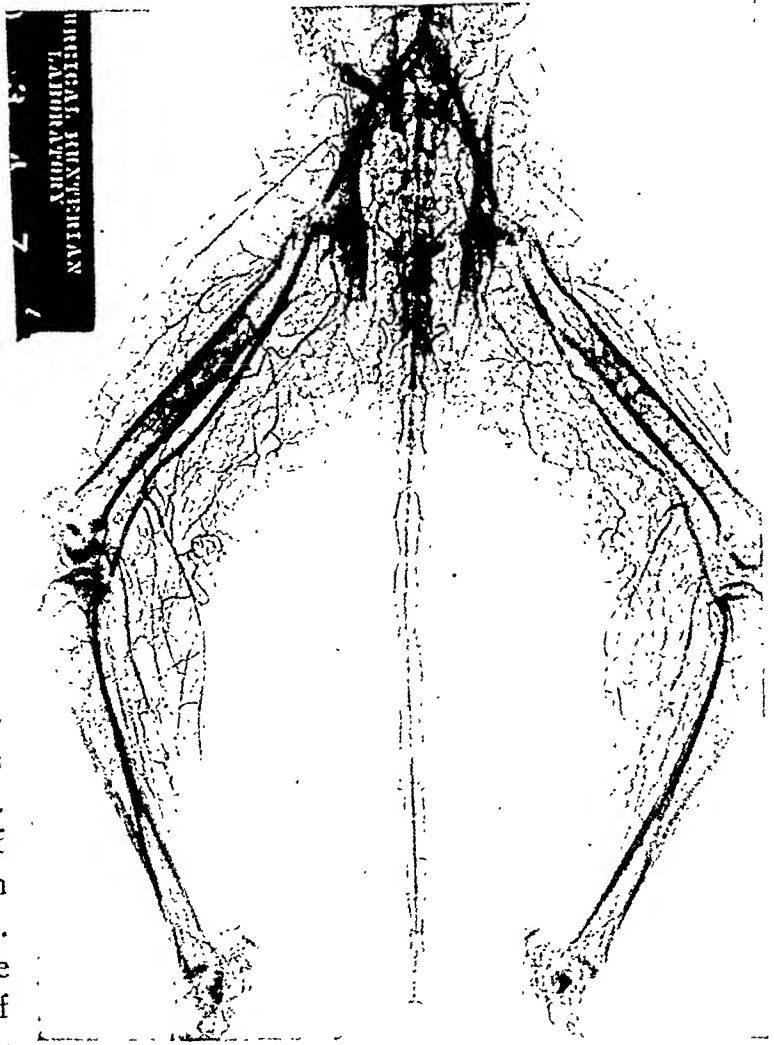


FIG. 3.—The arterial circulation with ligation of artery and vein according to Holman's principle (on the side with the marker) and ligation of the artery and vein at the same level.

It has been shown that after ligation of artery and vein the distal circulatory bed is much greater than after occlusion of the artery alone. This is considered to be the fundamental explanation of the improved function and diminished gangrene seen after ligation of both the artery and vein. It has been observed, also, that ligation of the vein proximal to the site of ligation of the artery according to Holman's principle results in a better vascular bed than does any other procedure.

The fallacy of explaining a delayed result on an immediate finding is obvious. It is not the increase in arterial pressure resulting from vein ligation that improves the results, since at the time one judges the results the arterial pressures have equalized. Rather, it is considered the fact that simultaneous

ligation of artery and vein results in an increased arterial vascular bed. The part played by the increased arterial pressure in producing this latter phenomena cannot be estimated. It is probable that it is one factor in its causation.

#### SUMMARY

(1) Ligation of a large artery should be accompanied by ligation of its companion vein. This results in improved function and diminished gangrene.

(2) The increased arterial pressure and blood volume flow observed in sacrifice experiments at the time of ligation of the vein are but transient phenomena.

(3) Survival experiments have demonstrated that ligation of the artery and vein results in a much richer vascular bed than that occurring after ligation of the artery alone.

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# CHRONIC POST-OPERATIVE TETANY

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FROM THE DIVISION OF SURGERY, JACKSON CLINIC

THE incidence of toxic goitre has increased rapidly in this country during the last decade in spite of the efforts that have been made for its prevention. Our knowledge concerning the etiology of this disease remains obscure, but there has been a marked advance in diagnosis and treatment. Statistics have demonstrated beyond a doubt that the early intervention by surgery in cases of toxic goitre is for the most part attended with success. The remarkable reduction in mortality after operation is due to the development of medical science and to the fact that patients are coming to operation sooner because of correct diagnosis. The perfection of the basal metabolic unit as an aid to clinical diagnosis, and the discovery of the efficacy of iodine as an aid to surgery in the treatment of exophthalmic goitre, have greatly aided in the successful treatment of this disease.

That the goitre question is one of interest to the medical profession is apparent from a survey of the literature. There is a goitre clinic in the majority of large cities and the number of patients coming to operation has rapidly increased in recent years. Through dissemination of knowledge of the end results of toxic goitre the incidence of cases of chronic myocarditis should decrease and the surgical mortality should decrease still further. With the greatly increased number of operations, however, an increase in surgical complications may likewise be expected. Because of the close proximity of the goitre to so many vital structures, the removal of this gland is always attended with a certain degree of risk. Injury to the recurrent laryngeal nerve, collapse of the trachea, hemorrhage, embolism, tetany, pneumonia, and tracheitis are only some of the possible complications that may develop after thyroidectomy. Fortunately these are not of common occurrence, and yet there is scarcely a surgeon who has not experienced one, or all of them.

The surgeon, in discussing the successful results of operation, may have a tendency to minimize the complications, and it is with the hope of stimulating further interest in the subject that I present the problem of tetany as a complication of thyroidectomy. This was a serious problem for those who first operated on goitre and in the clinics of Billroth and Kocher, it resulted in a high mortality. As surgeons became better acquainted with the condition they became more conservative, so that for many years the operation of choice was simple lobectomy. The end results of this operation likewise proved disappointing; it resulted frequently in incomplete cure or recurrence. Gradually the operation of resection as suggested by Mikulicz came into vogue. Frequently recurrences were still observed until within recent years

surgeons have learned that for successful results it is necessary to remove all but a small portion of the gland. If too much tissue is removed, injury to the recurrent laryngeal nerve may occur or tetany develop. Recurrence may follow the failure to remove enough of the gland. Although these complications are the exception, they occur even after most careful surgical technic.

Reports of post-operative tetany are numerous in the literature, but the statistical study of a group of cases has not been presented.

*Structure and Function of Parathyroid Glands.*—Post-operative tetany was first recognized by Wölfler in Billroth's Clinic in 1881. A year before this the first description of the parathyroid glands (thyroid glandules, epithelial bodies) was made by Sandström. These glands arise from the walls of the third and fourth bronchial clefts. They may vary in number and situation. Usually there are four and they are situated in pairs along the posterior surface of the thyroid, the superior at the upper pole and the inferior at the lower pole of the gland. According to MacCallum<sup>15</sup> they have no constant position and may appear singly or in groups; they may be on the surface or imbedded. They are in close relationship to the superior and inferior thyroid arteries, and according to Halsted and Evans receive their principal blood supply from the latter; they also receive some from anastomosing branches between the two. They are brown and soft, showing peripheral veins, and are formed of strands of cells, many of which have clear protoplasm in early youth, while in later life the predominant cells have a slightly granular cytoplasm, a few groups standing out by reason of their small dark nuclei and the bright eosinophile protoplasm.<sup>16</sup> The function of these cells has not been determined.

The literature concerning the parathyroid glands contains little of importance from the time of Sandström's exposition until 1891, when Gley rediscovered these glands. He felt that they were embryologically and physiologically related to the thyroid gland, and that when the latter was removed its duties were assumed by the parathyroid glands. Both Sandström and Gley felt that these glands were embryonic thyroid tissue which possessed the power of replacing the thyroid.

It remained for Vassale and Generali to disprove completely this theory and to establish the separate relationship of these glands. They were able to produce fatal tetany in animals by the removal of the parathyroid glands while preserving the thyroid. Tetany was prevented by preserving the parathyroid glands in spite of complete thyroidectomy.

The next advancement in our knowledge of the parathyroid glands was made by MacCallum and Vogel. These workers showed that the hyperexcitability of the nervous system is peripheral and is the result of an alteration in the blood. They were able to produce marked stimulation of the nerves by introducing blood from an animal with tetany into a normal animal. Further study of the blood from an animal suffering with tetany showed a low calcium content. MacCallum and Voegtlin, together with Parhon and



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Urechie, independently arrived at the same conclusion, that calcium is beneficial in cases of parathyroid tetany. They showed that this condition could be relieved by the use of a 5 per cent. solution of calcium lactate or acetate, orally or intravenously. Magnesium salts were found to be objectionable on account of their toxicity, while the administration of potassium salts intensified the symptoms.

That hydrochloric acid as well as calcium will relieve tetany in dogs was made known by Wilson, Stearns, and Janney in 1915. In their experiments with animals they found that the muscular contractions that occur in cases of tetany are apparently a compensatory effort on the part of the body. Alkalosis may occur but this is neutralized by the acid which is produced by the muscular contractions. Acidosis then develops and the tetany subsides. These interesting phenomena suggest further fields of study.

Paton and Findlay in studying the blood and urine of parathyroidectomized dogs found that guanidin and methylguanidin were present in considerably larger amounts than in normal animals. The same condition was found to exist in children with tetany. These findings apparently suggest some relationship between the two forms of tetany, but as yet there is no pathologic evidence to substantiate this.

In 1918, Howland and Marriott determined that the blood calcium in the serum of normal persons varies between 9.2 and 11.3 mg. (about 10 mg.) for each 100 c.c. of serum. The calcium in the serum of patients suffering from idiopathic tetany was reduced to an average of 5.6 mg. for each 100 c.c. of serum. They believed that convulsions develop if the blood calcium content becomes less than 7.0 mg. for each 100 c.c. This test has proved of great practical value and now governs the rationale of therapy.

Many preparations of parathyroid gland have been tried in the treatment of tetany, but none proved of value until in 1924, Collip found a parathyroid hormone which will prevent or control parathyroid tetany and regulate the level of blood calcium. He was able to show a marked rise in blood calcium content after injections of his extract in both normal and parathyroidectomized animals. Several reports have appeared in the literature in which this preparation has proved of definite benefit in the treatment of cases of tetany, and I am reporting three cases in which parathormone was administered (Cases II, III and V).

*Etiology of Tetany.*—Surgeons have generally agreed that only a small portion of gland along the posterior border should be preserved if thyroidectomy is to prove successful in patients with exophthalmic goitre. Preservation of too much gland results in only partial abatement of the disease or definite recurrence with exaggeration of symptoms. To protect the recurrent laryngeal nerves, the parathyroid glands, and the trachea, and yet remove sufficient thyroid gland, the operation must be carefully performed. The tendency to remove more and more tissue has perhaps accounted for increase in the incidence of tetany. On account of the minuteness of the parathyroid

glands and their close resemblance to the surrounding tissue it is difficult to detect them during operation. I believe it is impossible to demonstrate their presence when operating for adenomatous goitre because of the similarity of small adenomas to the parathyroid gland. Consequently the surgeon must be guided by anatomical relations and endeavor to preserve these small bodies by avoiding rather than seeking them. In removing adenomatous goitre the operator may realize that he is resecting more of the gland than desired, because in its degenerated condition the tissue seems to disappear before the knife. It may still be possible to preserve sufficient tissue to prevent injury to the parathyroid glands. Undoubtedly tetany in some cases is not the result of direct injury to the glands, but rather to a cutting off of their blood supply either through ligation of the vessels, or from oedema and scar tissue. It may be also that tetany is present in a potential state before operation. Herrick recently reported that he was able to demonstrate clinical signs of tetany in certain cases of goitre preceding operation. A patient with a large adenomatous goitre on whom I recently operated had for three years had typical tetany-like cramps in the hands and feet as well as the epigastrium. Definite clinical signs of tetany could not be elicited, however, and the amount of blood calcium was normal. Still it does not seem impossible that the rapid growth of a goitre might not cause some pressure atrophy of the parathyroid glands.

*Symptoms.*—The classical signs of tetany, best known by the names of those who first described them, need only to be mentioned. In 1851, Trousseau demonstrated that in the free intervals between spasms, attacks could be induced by exerting pressure over the main nerve trunk of the forearm either with the hands or a tourniquet. This is not easily obtained and in my experience is neither as simple or as satisfactory as Chvostek's sign. Chvostek, in 1907, found that by gently tapping along the course of the facial nerve, the muscles could be made to twitch so that the corner of the mouth or the ala of the nose is slightly drawn. In 1874, Erb showed that the electric excitability of the motor nerves is increased. This was clearly demonstrated in my Case V when a slight current caused my fingers merely to twitch, while it produced a violent contraction of the patient's entire body. Pool, in 1907, and Schlesinger, in 1910, produced contracture in the legs of patients with tetany by flexing the leg on the body, thus obtaining tension of the sciatic nerve.

Other signs have been described but none of these compares in value to that of determining the calcium in the blood; this portrays accurately the patient's condition.

There may be an acute onset of symptoms of post-operative tetany within twelve hours; it may be delayed for two or three days, or it may develop chronically after an interval of several months as in Case III. Boothby states that prodromal symptoms such as headache and general weakness, accompanied by radiating pains down the extremities, especially the upper, and

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chronic twitchings may occur. Only one of my patients complained of headache, but fleeting pains in the arms were mentioned by every patient. They all complained of stiffness in the hands and feet with a sensation of numbness and tingling as described by patients suffering from pernicious anæmia. A tentative diagnosis was made at this stage in two cases and treatment with calcium was begun. Coincident with the stiffness of the fingers, the face becomes stiff and drawn and soon a corner of the mouth may be definitely pulled to one side. Spasms develop in the hands and often in the feet. The hands may assume the typical contraction of the accoucheur's hand, the fingers flexed at the metacarpophalangeal joint, the hand flexed at the wrist, the thumb adducted, and the arm flexed at the elbow. These spasms may subside in a few minutes only to recur again soon. They may gradually become less severe, or they may progress to a fatal termination if the proper treatment is not instituted.

*Treatment.*—In my experience calcium administered either orally or intravenously has proved entirely satisfactory in controlling the attacks of tetany in all but one case. In this case Collip's parathormone injected intravenously proved most beneficial. In the five chronic cases reported here neither of these remedies effected cure.

In my cases of acute tetany a blood calcium test is made at the onset of prodromal symptoms. Calcium lactate is then given orally, three doses of 120 grains each at one-hour intervals. In case the symptoms do not subside, three additional doses are administered. Further treatment is based on the progress of the case and the laboratory data. In the mild transient cases I have observed, this amount of calcium has usually been sufficient to tide the patient over the period of temporary hypoparathyroidism. It may be necessary to decrease the doses gradually for several days.

Ten cubic centimetres of 5 per cent. solution of calcium lactate given in 100 c.c. of sodium chloride solution produces almost immediate relief in the more severe cases of tetany; the spasms subside and the other symptoms usually disappear in from ten to thirty minutes. Calcium lactate may still be given by mouth or by rectum, but in the transient acute cases one intravenous treatment will usually suffice.

The cause of this acute temporary form of tetany is not known. It has been supposed that there is a disturbance of the blood or the nerve supply of the parathyroid glands due to trauma or œdema. Possibly there is a destruction of one or more of the glands, and until those remaining can compensate, there is a period during which the parathyroid glands are unable to function properly. In cases in which the condition persists for several weeks and then clears, it may possibly be relieved by the establishment of collateral circulation. These cases need cause little concern; the real problem is what to do in case of chronic tetany. The symptoms in the five cases in my series have persisted two years from the time of operation. As long as calcium lactate is given orally in daily doses the condition is perfectly con-

trolled, as is myxœdema by thyroid feeding. The question is, must these patients continue taking calcium lactate indefinitely or is there some means of permanent relief?

Transplantation of the parathyroid glands has been advocated and tried by various surgeons since 1912, when Halsted reported a successful result in an experiment on a dog. Crotti states that if a parathyroid gland be inadvertently removed during an operation, it must be reimplanted at once in the thyroid tissue. He believes that the chances for this autotransplantation are very good. Theoretically this is plausible, but practically the question is whether or not, at the completion of an operation, a parathyroid gland has been damaged or removed? It is almost impossible to recognize the gland macroscopically in the midst of adenomatous tissue.

Crotti believes in regard to heterotransplantation that "in the majority of these cases this method has proved a failure. Its effects, as a rule, are only temporary and last only during the time necessary for the graft to become absorbed." If a parathyroid gland is to be transplanted Crotti states, and justly so, that the gland should not be removed from a normal patient. Kocher removed a gland from a person who had committed suicide, and Pool from a person who had died from a non-communicable disease. In such cases no effect of the graft may be expected for one or two months. The rectus muscle is the favorite site for transplantation.

Lahey recently reported that in a period of six months he transplanted parathyroid glands into the belly of the sterno-cleido-mastoid muscle in ten cases. Later twenty-six additional supposedly parathyroid glands were transplanted, but a microscopic examination showed that only four of these were actually proven to have been parathyroid glands, two were questionable and nineteen were probably lymph-glands. Lahey admits the difficulty of recognizing parathyroid glands macroscopically and states that a microscopic study should be made.

Transplantation of glands has in general, however, proved unsatisfactory and consequently the report by Collip on a parathyroid hormone was received with interest.

*Parathyroid Hormone.*—Collip stated that the function of the hormone in the normal animal appears to be that of a regulator of calcium metabolism and its action is primarily that of mobilizing calcium. It has been shown that parathyroid hormone relieves or prevents tetany when it is injected into parathyroidectomized animals. The injection of the hormone in both normal and parathyroidectomized dogs causes a definite mobilization of calcium in the blood stream. Collip warns against the danger of injecting excessive amounts of hormone and producing hypercalcæmia. This procedure should not be carried out unless blood calcium values are determined. In the animal the condition is evidenced by a great increase in inorganic phosphorus in both the whole blood and serum, an increase in urea and non-protein nitrogen, and a great increase in viscosity accompanied by a decrease in plasma

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volume. Anuria occurs and later acidosis. No fatal cases of hypercalcaemia in man following this treatment have been reported in the literature.

In one of my cases of tetany relief following the administration of parathormone was more prompt and beneficial than that obtained by the use of calcium, but the patient was not cured. However, Collip did not maintain that permanent relief would follow.

Snell<sup>27</sup> reported a case of chronic tetany in which the administration of calcium lactate brought about some improvement in the clinical condition, but did not raise the blood calcium. When parathormone was given with the calcium lactate, the blood calcium rose to normal, and all signs and symptoms of tetany disappeared. In a later report, however, he stated that the patient is now taking daily 15 gm. of calcium lactate and no parathormone.<sup>28</sup> He pointed out that in spite of the fact that the calcium metabolism was defective for a long time, normal blood calcium cannot be maintained by calcium alone. It was impossible to do this in the early treatment of the case until a course of parathormone had been given.

Lisser and Shepardson reported a case of post-operative tetany in which three parathyroid glands had been removed; the tetany was relieved by the administration of from 12.5 to 50 units of parathormone daily. Some symptoms of hypercalcaemia were observed. Later 5 gm. of calcium was given daily.

Lilly's parathormone is standardized by its capacity to increase the total calcium in the blood serum of normal dogs. One unit may be defined as one-hundredth the amount of extract required to cause an increase of 5 mg. of calcium in the blood serum of a dog weighing 20 kg., the rise of calcium being determined fifteen hours after the injection of the extract. Parathormone (Lilly) is supplied in 5-c.c. rubber-capped ampules. Each ampule contains 100 units and is designated as P-20, which indicates that there are 20 units in each cubic centimetre.

John recently reported interesting data and observations on his experience with parathormone in cases of chronic tetany. The conclusion that he deduced from the literature as well as his own experiments was that parathyroprival tetany is due to a disturbance of the mechanism which governs the metabolism of calcium. The essential element for the operation of this mechanism is supplied by parathormone. In his cases of chronic tetany a serum calcium content of not less than 8 mg. for each 100 c.c. was observed. He found that after the use of parathormone the symptoms of tetany are relieved and the calcium in the blood rises. A similar rise in the serum calcium content, together with a reaction, was seen after parathormone was given to normal persons. He believes that there is a psychological factor of tetany because relief was obtained in certain cases by only normal sodium chloride solution.

In my own experience with parathormone, which has been limited to three cases of chronic tetany, I found that this preparation was most valuable

in restoring temporarily the normal blood calcium (Case V). At the present time these patients are all taking calcium lactate by mouth; blood calcium is maintained at normal values and there are no symptoms of tetany.

*Ultra-violet Light.*—The favorable effect produced in cases of rickets in animals from treatment by ultra-violet light suggested this method to me as a means of treating cases of chronic tetany. One of my patients (Case V) had been receiving 600 grains of calcium lactate by mouth in daily doses for almost two years. On several occasions she had neglected treatment, so that twice it was necessary to administer calcium lactate intravenously to relieve acute exacerbations. At other times tetany was purposely induced so that parathormone might be administered: When there were no symptoms of tetany and the blood calcium was 9.5 mg. for each 100 c.c. of blood the dosage of calcium by mouth was reduced one-half. At the same time treatment with ultra-violet light was begun. In three days the blood calcium had fallen to 7.56 mg. and early signs of tetany were observed. The treatment with ultra-violet light was increased four minutes a day and no more calcium lactate was given. Five days later the blood calcium had risen to 9.15 mg., and all symptoms of tetany had disappeared. The condition continued to improve so that one month after treatment was instituted the blood calcium was 10.5 mg., that is, 1 mg. more than when treatment was begun. On the patient's return two weeks later the blood calcium was 10.8 mg. and she felt well. The dosage of calcium was again reduced one-half, this time with no visible effect. At this time she was receiving ultra-violet light treatments, thirty minutes daily. The dose of calcium has been reduced to one-eighth the original dosage, to approximately 75 grains a day. The patient has remained well and has received no ultra-violet light treatment for more than two months.

Deductions may not be made from a single case. The effect of the ultra-violet light may be merely transient and palliative. In view of the ever-increasing number of cases of chronic tetany now being reported, I believe this preliminary report may aid others to try this method and increase our knowledge in this difficult field.

After I had carried out this work I found in the literature a report on the subject by Grant and Gates. They performed experiments to determine the effect of ultra-violet light on the parathyroid glands of the rabbit, and found that exposure of the skin to a quartz mercury arc lamp, thirty minutes daily, caused a marked increase in the weight of these glands. This increase, which was 56 per cent. of the normal weight, began during the first few days of exposure. It was more remarkable in that it occurred during a period when the glands were normally undergoing an apparently seasonal diminution in weight. In working with normal animals it was found that hypertrophy of the parathyroid did not result with a corresponding increase in the calcium content of the blood when the calcium concentration was already at, or near, the normal level. Grant and Gates felt that one of the results of exposure

of the skin to ultra-violet light was slight alteration in the composition of the blood. The parathyroid glands are sensitive to this, and their reaction is to hypertrophy.

Salvesen injected calcium lactate into dogs after removing the parathyroid glands and he observed a temporary increase in the blood calcium, which he felt was due to a rapid elimination, for the most part through the intestines, of the calcium which had been injected.

Orr, Holt, Wilkins, and Boone found, in cases of active rickets in children, when there is very little retention of calcium in the body and the blood calcium values are low, that exposure to ultra-violet light caused greatly increased retention of calcium and phosphorus.

These experiments suggested to me the problem of determining the effect of the ultra-violet light on the calcium metabolism of parathyroidectomized animals. Swingle and Rhinhold found that there was no change in the calcium content of the blood serum after animals with tetany had been treated by ultra-violet light. They were able, however, greatly to prolong the life of these animals and to modify the symptoms. I believe this matter should receive further study.

John, in a report on chronic tetany, presented the chart of a patient who had received two treatments of ultra-violet light without apparent effect. He did not discuss the subject, although he mentioned the work of Denis and Corley, who found that daily exposure to ultra-violet light had no effect on the calcium content of the tissues or serum. Here again, however, as in the experiments of Grant and Gates, the studies were made on normal animals.

*Diet.*—Luckhardt emphasized the importance of prescribing a diet with a high calcium content; this includes milk, peas, beans, eggs, and sauerkraut. In his early investigation which he made with Rosenbloom he found that the poison responsible for tetany is of exogenous origin, and that it is found particularly in meat. They were able, by feeding meat to an animal to precipitate an almost fatal attack of tetany thirty-three days after parathyroidectomy. It was found important to prevent constipation. They were able to keep parathyroidectomized animals alive by the intravenous injection of Ringer's solution and after about forty days no symptoms of tetany were noted.

#### REPORT OF CASES

CASE I.—A woman, aged thirty-six, who came to the Clinic December 1, 1924, with severe exophthalmic goitre, had taken iodine at home for the last year. She had lost 50 pounds. The loss in quadriceps was graded 4, and the basal metabolic rate was +49. She had chronic myocarditis, œdema of the legs, and mitral insufficiency. The case was considered only a fair surgical risk, and the usual pre-operative treatment was instituted.

December 11, primary thyroidectomy was performed. There was partial resection of the right lobe, isthmus, and left lobe. One-fourth of a normal lobe on the right and one-third on the left were preserved. Convalescence was uneventful. The patient left the hospital on the fourth day and on the following day she came to the Clinic

for a dressing. On January 2, 1925, she was ready to make the journey home but complained of stiffness and contractions in the hands. Two grains of thyroid extract and 10 grains of calcium lactate were given three times daily. January 7, there was no improvement. One-tenth grain parathyroid extract was given three times daily in addition to the thyroid extract and calcium lactate. The basal metabolic rate was +20. The patient had gained 7 pounds. January 17, there was no relief and the patient had another attack of cramps; 4 gm. of a 10 per cent. solution of calcium lactate was given every three hours during an attack, and she was dismissed from observation.

The patient wrote in a letter of May 11 that she had been having mild attacks of cramps three or four times a week. She now complains of a severe rheumatic pain



FIG. 1.—Case of chronic post-operative tetany. Note the muscular contraction of the face and hands.

in the left forearm and hand that is not relieved by calcium lactate. She returned to the Clinic May 20, and was examined for tetany. The blood calcium was 8 mg. for each 100 c.c. of blood serum; 50 grains of calcium lactate was given three times daily and the patient received a full milk diet. The basal metabolic rate was +4. On May 23, a Röntgen-ray examination revealed periostitis of the median third of the mesial aspect of the ulna. No relief of the pain could be obtained by giving calcium even when it was administered intravenously. On June 8, tonsillectomy was performed. December 4, the patient stated in a letter that she had gained 40 pounds, was free from all symptoms, and five months' pregnant. I received indirect information that she died at the time of childbirth, but I was unable to ascertain whether or not tetany was a factor.

CASE II.—A woman, aged fifty, came to the Clinic January 17, 1925, because of multiple non-toxic substernal adenoma of the thyroid. Her chief complaint was dyspnoea. Clinical examination revealed an unusually hard nodular gland, suggesting a calcareous or possible malignant change. At operation the left lobe was found to be hard, and suggested calcareous change throughout. A portion two-thirds the size of the normal lobe was preserved on both sides as usual. The inferior thyroid arteries were not separately ligated. Eighteen hours after operation the patient complained of numbness and stiffness



in the hands and a drawn feeling in the face; she seemed nervous and apprehensive. The house physician, suspecting the development of tetany found that the calcium content of the blood was 10 mg. for each 100 c.c. The symptoms progressed in spite of the administration of 30 grains of a 10 per cent. solution of calcium lactate three times daily. During a mild attack the calcium content fell to 7 mg. for each 100 c.c. and during a severe attack it was only 4 mg. Almost instant relief was obtained by the intravenous administration of calcium chloride and milk was found beneficial (Fig. 1).

February 19 the patient reported that during the two weeks she had been home she had suffered one severe attack of cramps and one mild one. She was taking 30 grains of calcium lactate three times daily. The basal metabolic rate was +9. On April 6, she was free from tetany. On May 26, she reported that she had had occasional mild cramps each week or two, but was much better, especially when she abstained from eating meat. More than a year later she was still having occasional mild cramps; June 3, 1926, she had a more severe attack and the family physician gave a larger dose of calcium lactate with relief. The next day she had 5 units of parathormone. The calcium lactate was increased to 50 grains, three times daily, together with 10 grains calcium carbonate. This was suggested to aid in the absorption of lactate. June 18, the cramps had subsided but treatment was continued and the patient has remained free from symptoms. The blood calcium was 9.6 mg. for each 100 c.c. If I had known what I do at the present time, I should have given a larger dose of calcium lactate at the start and more parathormone.

CASE III.—A woman, aged forty-eight, came to the Clinic, April 21, 1925, because of exophthalmic goitre. This was a severe case and is the most unusual and remarkable instance of tetany that I know. The patient had passed through two gastro-intestinal crises during the last year; each time she was confined to bed for many weeks. When she was first seen she was on the verge of a third crisis. She had been in bed much of the time for several months. The response to treatment was rapid and on May 3, primary thyroidectomy was performed. There was nothing unusual about the operation or the pathologic findings. The gland was very friable and vascular showing some reversion to colloid. The usual strip of gland along the posterior border was preserved. Convalescence was uneventful and the patient was dismissed from observation May 23, twenty days after operation. The basal metabolic rate was +1, and the weight 148 pounds. June 19, she came for three physiotherapy treatments and was gaining rapidly. December 4, she weighed 190 pounds, the pulse rate was 72, and she was considered cured. January 9, 1926, she weighed 220 pounds, having gained rapidly during the last ten months. She had become childish; her voice was deep; there was some dryness and scaling of the skin; the ankles were swollen; the abdomen was bloated, and the region under the eyes was puffy. She suffered from the cold. The responses were quick; there was no loss of hair; there was a strong suggestion of myxœdema, but the case was atypical and the basal metabolic rate was 0. In spite of this, 10 mg. of thyroxin was given March 13, with no apparent improvement.

Because six weeks previously the patient had fallen and struck her head, had lost consciousness, and blood had run from the ears, the possibility of a fracture of the skull was considered. The röntgenogram revealed no evidence of fracture. The depth of the arterial sulci indicated intracranial pressure. The attacks since this accident suggested petit mal.

When the patient was admitted to hospital her condition became progressively worse. The picture assumed that of cardionephritis with generalized œdema, convulsions, vomiting, anuria, an irrational state, and beginning choked discs. Heroic measures were apparently used to preserve life. Blood urea and renal functional tests were normal. There was slight improvement and then a more typical tetanic spasm developed.

May 11, the blood calcium was 5.9 mg. for each 100 c.c. This test, together with the clinical signs and symptoms, indicated an atypical case of tetany, and calcium lactate was given in large doses by mouth; the convulsions continued and calcium lactate was

given intravenously with only slight relief. Parathormone was given subcutaneously and still the convulsions persisted. Relief was not obtained until parathormone was given intravenously. The blood calcium was 7.4 mg. for each 100 c.c. On May 25, the blood calcium was 8.56 mg. and there was steady improvement. June 1, the patient was taking 500 grains of calcium lactate and 150 grains of calcium carbonate daily, and 1 grain thyroid extract three times daily. July 12, the blood calcium was 10.1 mg. for each 100 c.c. and the mental condition was more nearly normal. The patient weighed 203 pounds and was walking better. September 20, the blood calcium was 10.25 mg. for each 100 c.c. The patient was feeling well, was more active, and weighed 189 pounds. December 28, the blood calcium was 11 mg. Her condition seemed normal, and she weighed 176 pounds.

*Comment.*—The unusual features of this case are that symptoms of tetany did not develop until eight months after operation; the atypical onset suggested myxœdema rather than tetany. Repeated basal metabolic tests were normal, however, and no clinical improvement resulted from the administration of thyroxin. The mental evolution was unusual in my experience. During the entire time the patient maintained a humorous child-like attitude. It was the only case in which blood calcium was not raised by the intravenous injection of calcium lactate. Even the subcutaneous injection of parathormone was ineffective.

CASE IV.—A man, aged fifty-six, came to the Clinic March 4, 1926, because of exophthalmic goitre with secondary chronic myocarditis and cardiac arrhythmia. Several months previously his condition had been diagnosed elsewhere as a primary cardiac lesion and he had been confined to bed most of the time since then. He came to the Clinic on the verge of a crisis in an emaciated condition, having lost more than 40 pounds. The basal metabolic rate was +59. March 18, after eight days' preparation, primary thyroidectomy was performed in the usual manner. The gland was unusually large and showed considerable reversion to colloid; a part of the gland, about one-fourth of a normal-sized one, was preserved on each side.

March 21, the patient complained of a dull pain in the left shoulder, and of numbness and a stinging sensation in the right arm and hand. The right thumb was stiff and immovable. Three days later there were no further complaints and he left the hospital. March 26, the patient complained of numbness and tingling in the hands and feet with a tendency to cramps. Examination showed a bilateral Chvostek's sign 2+. Trousseau's sign was not demonstrable. Beginning tetany was evident. The blood calcium was 6.99 mg. for each 100 c.c., and 100 grains of calcium lactate was given orally three times daily. April 2, the basal metabolic rate was +20. The patient gained rapidly and there were no further signs of tetany. April 26, he had gained 20 pounds and was much stronger, although he was dizzy at times. He had not been taking calcium lactate for four days but felt slight numbness in the hands and feet. May 5, there were no signs or symptoms of tetany. June 26, the patient had gained 40 pounds, was again taking calcium, but noticed slight numbness in the hands. There was no Chvostek's sign. February 10, 1927, he still had occasional mild cramps in the hands and feet, and Chvostek's sign 1+. Fifty grains of calcium lactate and 10 grains calcium carbonate were given three times daily. February 15, the blood calcium was 8.08 mg.; the patient had been eight days without calcium lactate. He complained of numbness in the hands, and treatment was resumed.

*Comment.*—In time this condition may clear up and the tetany disappear. The patient had been allowed a general diet because of the mildness of his symptoms. Before his admission he had been bedridden for months and his

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condition considered hopeless. He has not regained his health, although he has gained more than 40 pounds. The cardiac arrhythmia has cleared up. He was advised to rest but spent most of the winter hauling logs.

CASE V.—A woman, aged forty-nine, came to the Clinic, May 28, 1925, because of multiple toxic adenoma with secondary hypertension and myocarditis. Her case has proved one of consistently severe and chronic tetany. The marked improvement following exposure to ultra-violet light has been encouraging (Fig. 2).

Thyroidectomy was performed July 9. On the following day the patient complained of stiffness in the hands and feet. July 11, the symptoms persisted and three 30-grain

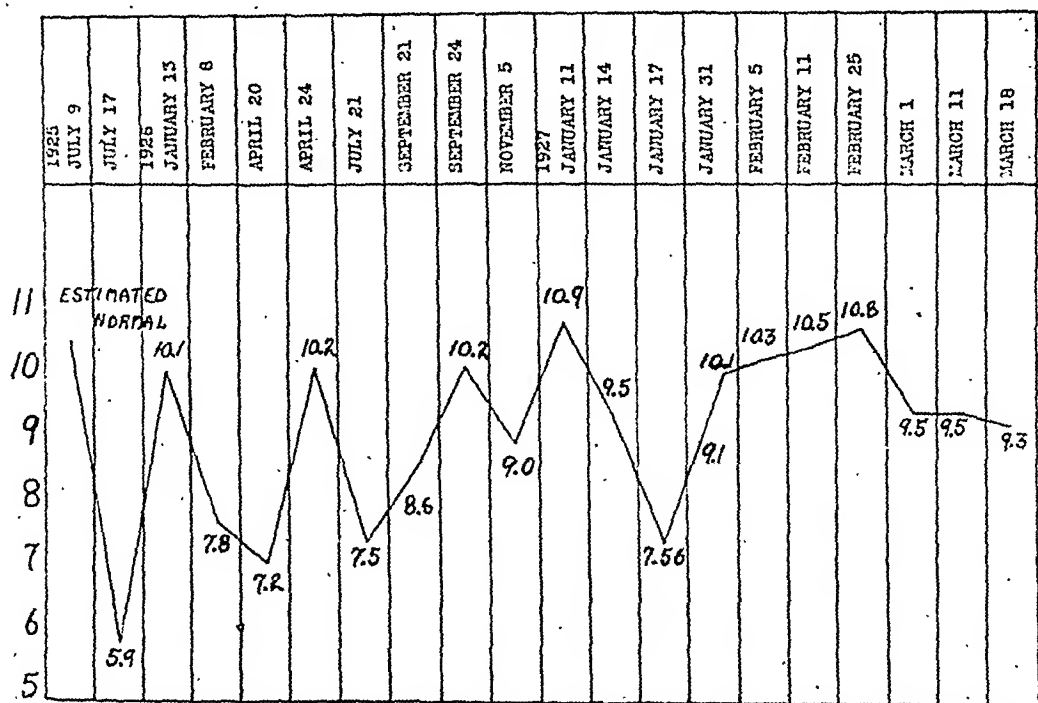


FIG. 2.—The curve shows the effect of the ultra-violet light treatments on the blood calcium in milligrams for each 100 c.c.

doses of calcium lactate were administered during the day. July 15, she left the hospital and July 17, she was re-admitted because of symptoms of severe tetany. She was given 50 c.c. of a 1 per cent. solution of calcium lactate intravenously and July 23, she was taking 120 grains calcium lactate daily. The tetany was controlled. December 2, the hands still showed tetanic contractions and on December 5, she was given two intravenous doses of calcium lactate which considerably improved the condition. They recurred, however, January 6, 1926, and on January 13, Chvostek's sign was 2+. Two intravenous doses of calcium lactate were given in forty-eight hours. January 22 and 23, 1 c.c. of parathormone was given three times daily with immediate relief. February 3, the patient had been taking 100 grains calcium lactate three times daily and began taking 1 c.c. parathormone daily. This relieved the spasm in five minutes. Three days later the condition was much better and she was taking only parathormone. February 8, slight stiffness was noted; the calcium lactate was resumed in 200 grain doses three times daily, and she was dismissed from observation.

April 20, the patient returned with symptoms of severe tetany. Her condition had been good until she stopped taking calcium lactate. She was given a hot bath, and calcium lactate was given intravenously. April 24, she was again dismissed from observation with instructions to take 200 grains calcium lactate three times daily.

July 21, the patient reported that she was feeling well. However, she was not

absorbing the calcium lactate so 25 grains calcium carbonate was added three times daily. September 21, she was feeling well and there were no further symptoms of tetany. She was given 1 c.c. parathormone daily. September 24, the parathormone raised the blood calcium. November 5, she was still feeling well; the calcium lactate was discontinued and the recurrence of symptoms was observed; 1 c.c. of parathormone had no effect but the dose repeated in ten minutes gave relief. January 11, 1927, there were no symptoms of tetany or Chvostek's sign, and all calcium was discontinued for three days. January 12, there was Chvostek's sign 1+ but no Trousseau's sign. January 13, there was Chvostek's sign 2+. January 14, tetany had begun to develop and the patient had to take calcium lactate one hour before the test. She complained of headache and pain in the legs and arms. Erb's sign was +++. On the following day ultra-violet light treatments were begun and 100 grains calcium lactate given three times daily. The regular dosage of calcium lactate was reduced one-half and 10 grains calcium carbonate added three times daily. January 17, tetany developed in the hands and Chvostek's sign was 2+. January 21, the patient's condition was improved. There were no symptoms of tetany. The effect of the ultra-violet light treatments was remarkable, and they were discontinued February 5. February 11, she felt well and returned home for two weeks with the instructions to take one-half the usual dose of calcium lactate. February 25, she reported that she was feeling better than ever; the ultra-violet light treatments were resumed. February 28, the calcium lactate dosage was reduced to 150 grains daily. March 1, there were no signs of tetany. March 11, the calcium lactate was reduced to 75 grains daily. March 18, she was again sent home for two weeks. She complained of occasional slight stiffness in the fingers. August 1, the blood calcium was still normal and the patient was still taking 75 grains calcium lactate a day without further ultra-violet light treatment.

*Comment.*—This case is the only one in which anything unusual occurred during the course of operation. One-third of a normal lobe was preserved on each side. The gland was friable and the right inferior thyroid artery tore loose. The nerve may have been caught when the artery was sutured as hoarseness followed immediately; consequently the suture was later cut and the vessel tied separately. There was only transitory involvement of the nerve, but possibly the blood supply of the right parathyroid glands was cut off.

#### CONCLUSIONS

1. The radical type of thyroidectomy necessary to obtain cure and prevent recurrence has resulted in an increased incidence of post-operative tetany.
2. The number of cases of chronic post-operative tetany in the literature is small, possibly because unsatisfactory results are not reported.
3. This series of cases is reported in the hope that it will further stimulate a study of the problem and possibly lead to more satisfactory methods of treatment.
4. Considerable scientific study has been made of this problem, but there is a lack of clinical correlation.
5. Calcium and parathormone are the two agents that have proved most effective in the treatment of tetany. Neither is a cure for the chronic type of tetany.
6. Transplantation of parathyroid glands has not proved generally effective because of the difficulty of recognizing the gland at operation.

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7. In this series of cases one patient was markedly benefited by the use of ultra-violet light. Sufficient time has not elapsed to determine the ultimate result.

8. The onset of symptoms may be acute or tetany may develop several months after operation. It may be atypical.

9. Parathormone was used with beneficial but not curative effect in three cases.

10. A diet high in calcium, the prevention of constipation, and plenty of sunshine are advised.

11. As might be expected, tetany has no effect on the basal metabolism. The basal metabolic rate was normal in these cases during the course of the tetany.

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# THE USE OF LUGOL'S SOLUTION IN EXOPHTHALMIC GOITRE

AN EXPLANATION FOR THE BENEFICIAL RESULTS OF PRE-OPERATIVE MEDICATION

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THAT the administration of iodine prior to operation for exophthalmic goitre controls the symptoms, lowers the basal metabolic rate and lessens the hazards of operation, is no longer questioned. This teaching, however, is directly contrary to that of only a few years ago. Formerly the surgical school led by Kocher opposed the use of iodine in any form of Graves' disease, holding that it increases the severity of the symptoms and may, in fact, be responsible for the development of exophthalmic from simple goitre.

The older literature contains numerous reports of unfavorable results from the use of iodine in various states of toxic goitre. We now realize that many of these accidents probably resulted either from the use of excessive doses or from moderate doses too long continued; others followed the administration of desiccated thyroid extract or thyroxin. However, these unfavorable reports served to crystallize in the medical mind a dread of the evil consequences of iodine medication in exophthalmic goitre.

Nevertheless there were occasional reports of remarkable results from iodine therapy. Cheadle,<sup>1</sup> in 1869, reported two cases of Graves' disease showing immediate and extraordinary improvement after iodine treatment. In 1875, he added a second series of six cases. One of the latter was very instructive: The patient improved rapidly during the first two weeks of iodine treatment but then relapsed. This case exemplifies the status of iodine treatment as we see it so commonly to-day.

Marine and Lenhart,<sup>2</sup> in 1911, showed that iodine may produce involution in the hyperplastic thyroid gland and recommended its use to prevent hyperplasia.

Ohlemann,<sup>3</sup> in 1913, reported that he had cured himself of Graves' disease by taking about 150 c.c. of tincture of iodine and a little potassium iodide occasionally over a period of three years.

Neisser,<sup>4</sup> in 1920, disagreeing with the generally accepted view regarding the contraindication of iodine in exophthalmic goitre, observed notable improvement and freedom from ill effects following the use of small doses.

Loewy and Zondek,<sup>5</sup> in 1921, observed a reduction in the basal metabolic rate and improvement in the nutrition and general subjective condition of the patient after administering a few mg. of potassium iodide daily.

*Lugol's Solution for Pre-operative Treatment.*—In March, 1922, Plummer<sup>6</sup> began the use of Lugol's solution in the Mayo Clinic as a pre-operative measure for the treatment of exophthalmic goitre. This treatment, as finally elaborated, consists of the administration of 10 minims of Lugol's solution three times a day for the first ten days. This dosage is continued up to operation and throughout the post-operative reaction, even though operation be postponed for several weeks. After the post-operative reaction, 10 minims daily are given as a routine for eight weeks. When a crisis occurs or immediate control is necessary, Plummer advises the administration of from 50 to 100 minims in divided doses by mouth or rectum within one or two hours.

Plummer<sup>7</sup> reports that the pre-operative use of Lugol's solution in the Mayo Clinic

reduced the surgical mortality from 3.5 per cent. to approximately 1 per cent. Likewise, the pre-operative mortality was decreased from 2.5-3 per cent. to 0.2-0.5 per cent., and the fatalities in the treated group occurred from complications not attributable to the condition of the thyroid gland.

Plummer and Boothby,<sup>8</sup> in 1924, reported on the use of Lugol's solution as a pre-operative measure in cases of exophthalmic goitre. In a series of 600 cases, no patient with unquestioned exophthalmic goitre was made worse by the treatment; approximately two-thirds were greatly benefited; only one patient in twenty was not demonstrably improved. The Lugol's solution was given in an average dose of 10 drops daily, well diluted and followed by a glass of water. When not tolerated by mouth, it was administered by rectum. The latter route, however, was required only for patients with severe gastro-intestinal crises and then only for a few days.

The observations of Plummer and Boothby have been abundantly confirmed. Mason,<sup>9</sup> in 1924, showed that compound iodine solution controls the toxicity arising from regeneration of thyroid tissue after thyroidectomy. This result he interpreted as an indication that the increased activity of the regenerated cells is of the same, or closely allied, nature as that of the cells of the original gland.

Starr and Means<sup>10</sup> in the same year reported excellent results following the administration of 15 drops of Lugol's solution daily to patients with exophthalmic goitre. In some cases the basal metabolic rate fell within a few days from plus 50 or 60 to plus 10 or 20; in others, to normal or even below. The pulse became slow and the appetite normal, nervousness and tremor diminished, and the weight increased. They concluded that the use of Lugol's solution by mouth produces abrupt remissions in many cases of exophthalmic goitre. In a later communication, Starr, Walcott, Segall and Means<sup>11</sup> showed that the remission after iodine treatment is as immediate and extensive as that following subtotal thyroidectomy, but that iodine alone cannot suppress Graves' disease permanently. If iodine medication is discontinued, a rapid rise of the basal metabolic rate and an exaggeration of the symptoms occur within one or two weeks. Like Plummer and Boothby, they observed that iodine medication is sometimes without effect.

In 1925, Boothby<sup>12</sup> reiterated that iodine, given to patients with exophthalmic goitre, usually reduces the basal metabolic rate and practically always causes the nervous and gastro-intestinal symptoms to disappear. However, he cautioned against its use in cases of adenomatous goitre without hyperthyroidism, since toxic symptoms may be induced thereby. Properly administered, Lugol's solution, according to Boothby, prevents death from acute post-operative exophthalmic goitre crisis. He believes that, with a few exceptions, iodine should be given only as a temporary therapeutic measure to bring the patient into a safe condition for partial thyroidectomy.

Read,<sup>13</sup> in 1925, reported twenty-six cases of thyrotoxicosis, in some of which operation had been performed, in which compound iodine solution was administered. In eleven cases there was marked improvement; in eight, moderate benefit; in six, slight or negligible change. No patient in the series was made worse by the treatment.

Clute,<sup>14</sup> in 1926, reported on the use of iodine as a pre-operative measure in association with rest in bed for from seven to ten days. Sixty-nine cases were selected for detailed study. It was found that before the use of Lugol's solution and rest in bed, only 38 per cent. of patients were operated on in one stage; whereas, since the installation of that treatment, 63.7 per cent. were operated on in one stage.

In Switzerland, Merkle<sup>15</sup> confirmed the excellent results of using Lugol's solution as a pre-operative measure in cases of exophthalmic goitre. In his experience, the optimum condition was obtained after eight days of treatment; but this improvement was only temporary, and the condition became worse when treatment was discontinued. He therefore believes that iodine should be used only as a preparation for operation.

Helmholz,<sup>16</sup> in 1926, reported on the use of Lugol's solution as a pre-operative



measure for exophthalmic goitre in children. In thirty cases occurring in children under the age of fifteen, compound iodine solution, administered in doses of from 5 to 10 minims three times a day, reduced the basal metabolic rate and controlled the toxic symptoms to a marked degree. In fourteen of the cases, the average reduction following iodine medication was 19 points. In the last eleven cases, the treatment made preliminary operation unnecessary.

Graham<sup>17</sup> believes that the pre-operative administration of Lugol's solution is safe and beneficial not only in exophthalmic goitre, but also in so-called toxic adenoma. In his opinion, the condition of the thyroid gland itself determines the one and only indication for the administration of iodine to any patient with goitre. If the gland is hypertrophic and hyperplastic, preliminary iodine is indicated, regardless of clinical grouping and the presence or absence of adenoma. On the other hand, if the thyroid is in a colloid or resting state (involution, not degeneration), there is no indication for iodine so far as thyroid function is concerned, and its use may be detrimental.

Altogether the great mass of clinical evidence substantiates the view that the pre-operative administration of compound iodine solution in cases of exophthalmic goitre is a safe and decidedly beneficial measure.

*How Lugol's Solution Acts.*—With regard to the manner in which Lugol's solution acts, there is great diversity of opinion. Plummer<sup>18</sup> attributed the toxic symptoms of Graves' disease to iodine starvation, resulting in incomplete iodization of the hormone thyroxin. His theory was that, without the addition of sufficient iodine, the thyroxin is toxic; that is, that the iodine in the gland detoxicates the thyroxin. This hypothesis, however, is not supported by sufficient facts.

For some time past in connection with my operative work on patients with hyperplastic goitres, I have repeatedly made an observation which, I believe, throws some light on the mechanism by which Lugol's solution acts. When the patient has been treated with a preliminary course of compound iodine solution, the thyroid gland at operation is found to be very œdematous. When the gland is sectioned, a watery fluid exudes freely from the cut surfaces. This condition is not true of hyperplastic thyroids not treated previously with Lugol's solution, nor of ordinary colloid goitre.

This observation has led me to believe that the beneficial effects of iodine medication are brought about by a rapid formation of colloid material in a gland famished for iodine, resulting in back pressure not only on the cells and acini, but also on the thin-walled veins surrounding the acini. In my opinion, this back pressure causes the passive œdema that we find at operation.

It is reasonable to suppose that the œdematous condition of the gland renders the secreting cells temporarily inactive, thus effectively preventing the absorption of the toxic substance. Hence the patient's condition improves. In the course of time, however, new blood-vessels are formed and the older ones gradually accommodate themselves to the changed condition. Then absorption takes place again and the patient once more becomes toxic, even though the colloid formation may still persist in the gland.

A similar conclusion to mine has been reached by Marine,<sup>19</sup> who studied the effects of iodine administration in various lower animals. Marine observed that in dogs the thyroid gland, previously soft and spongy because of the marked hyperplasia, became very firm as early as the fourth day after the administration of large doses of tincture of iodine. Numerous histologic examinations showed this firmness to be due to the accumulation of colloid material. Marine also calls attention to a clinical fact observed in connection with the iodine treatment of simple goitre. Such patients often return about seven days after beginning treatment, complaining that the gland is actually larger, firmer to the touch and very painful (so-called iodine thyroiditis).

My clinical observations on the condition of hyperplastic thyroid glands found at operation in patients previously treated with Lugol's solution have led me independently to reach the same conclusion as Marine,<sup>20</sup> who formulated his views as follows:

"A much more rational view of the beneficial effects of iodine in cases of Graves' disease with marked hyperplasia is that the administration of large doses of iodine (especially inorganic) causes a rapid accumulation of colloid in the alveolar spaces just as the administration of iodine to cases with marked hyperplasia of other clinical associations in man, dogs, sheep, birds and fish. The rapid distention of the alveoli with colloid brings about a *pressure retention* which temporarily blocks excretion until the thyroid cells have accommodated themselves to the increased tension. Excretion is then reestablished and the metabolism begins to rise."

Other workers have reported observations on changes in the structure of hyperplastic thyroid glands as a result of iodine medication. Cattell<sup>21</sup> showed that iodine therapy causes marked changes both in the iodine content of the gland and its pathologic structure. He found a direct ratio between the degree of involution and the iodine content, thus confirming the observation that the iodine content of the hyperplastic thyroid gland is inversely proportional to the degree of hyperplasia. Pathologically, he found the papillary projections with high epithelium replaced by vesicles lined with low epithelium and filled with colloid material.

In a comparative series of thirty patients with Graves' disease, fifteen of whom were treated pre-operatively with iodine and fifteen without, Rienhoff<sup>22</sup> established the fact that preliminary iodine therapy is associated with a change in the histologic appearance of the gland from a hyperplastic to a colloid state, even though there is definite evidence of the hyperplasia still remaining. He observed that after iodine treatment the size of the gland as a whole is increased but that its vascularity, and probably also the lymph flow through the gland, is diminished. There was a striking increase in the amount of colloid deposited within the gland and also a large increase in the amount of fibrous connective tissue. Definite changes were observed in the acini. They were transformed from lace-like papillomatous ingrowths to round, even-walled, smooth acini of regular size and form. High columnar epithelium gave way to flat cuboidal and occasionally low columnar epithelium. The large clear nuclei of the epithelial cells in the untreated glands were replaced by the small, irregular, pycnotic type in the treated glands. Mitotic figures in the nuclei, so common in untreated cases, were absent when the patient received preliminary iodine medication. Rienhoff likens the change produced by iodine medication to an artificial remission of the thyroid hyperplasia.

Giordano<sup>23</sup> likewise found histologic evidence supporting the view that involution changes occur in the thyroid gland when iodine is administered to patients with exoph-

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thalmic goitre. In general, the degree of this involution closely paralleled the clinical course. The changes resembled those following preliminary ligation of the thyroid vessels, except that they were distributed uniformly throughout the gland.

### SUMMARY

It is now fully established that the pre-operative administration of Lugol's solution to patients with exophthalmic goitre lowers the basal metabolic rate, controls the toxic symptoms and lessens the hazards of operation. However, opinions as to the mechanism by which iodine medication benefits the patient are still far from unanimous.

That the toxic symptoms of Graves' disease are associated with iodine starvation of the thyroid acini, cannot be questioned. Hence it was reasonable to assume that iodine acts by detoxicating an incompletely iodized thyroxin molecule. This view, however, is largely speculative and not supported by sufficient evidence.

In removing hyperplastic thyroid glands of patients previously subjected to iodine medication, I have repeatedly observed that the glands are very œdematous; so much so, that water exudes freely from the cut surfaces when the glands are sectioned. This condition is not true of hyperplastic glands without iodine treatment, nor of ordinary colloid goitre.

From this observation I have come to believe that the beneficial influence of Lugol's solution is brought about by a rapid formation of colloid material in the iodine-famished gland, resulting in back pressure on the secreting cells and the thin-walled veins surrounding the acini. Hence passive œdema follows and the cells, rendered temporarily inactive, fail to absorb the toxic substance; consequently the patient's clinical condition improves. In the course of time, new blood-vessels are formed and the older ones accommodate themselves to the changed conditions, so that absorption is resumed and the patient again becomes toxic, notwithstanding the fact that the colloid material may persist in the acini.

The explanation I have given would account for the fact that improvement from iodine medication is only temporary. It is in accord with Marine's views, based largely on experimental observations on animals, and consistent with the recorded changes in thyroid glands removed after preliminary treatment with Lugol's solution.

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# EFFECT OF HYPERTHYROIDISM UPON DIABETES MELLITUS

STRIKING IMPROVEMENT IN DIABETES MELLITUS FROM THYROIDECTOMY

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WE WISH to emphasize the remarkable improvement in carbohydrate tolerance following subtotal thyroidectomy in diabetes mellitus complicated by hyperthyroidism, and to discuss important factors in the management of this problem, more particularly from a surgical viewpoint. This specific syndrome has in the past been attended with a high mortality which has now been almost eliminated since both conditions can be improved to a point where operative removal of portions of the thyroid can be done without undue risk.

Diabetes mellitus is a condition in which less than the normal amount of glucose can be oxidized in a unit of time. When the fat burned is more than four times the glucose burned acidosis occurs. If the diet does not supply the total calories, the extra calories of the metabolism are derived from body fat. In hyperthyroidism with its high metabolic rate, the total metabolism may be twice that of the ordinary diabetic patient, accordingly, when these two conditions exist together the usual diabetic diet may supply half or less of the calories consumed and the remainder will come from the patient's body fat. The entrance of this very large amount of fat into the metabolic mixture, combined with the inability to oxidize a sufficient amount of glucose (because of the diabetic state), results in acidosis. The use of insulin in amounts sufficient to cause the combustion of the proper amount of glucose on one hand, and the lowering of the metabolic rate by iodine on the other hand, work together to bring the patient to a safe condition for operation.

The literature bearing upon the subject has been reviewed recently from a clinical metabolic standpoint by Wilder<sup>1</sup> and from an experimental viewpoint by Allen.<sup>2</sup> The surgical aspects of this problem have not been comprehensively dealt with, although occasional case reports have appeared. The surgical attack on the thyroid has been carried out on (a) normal glands, (b) adenoma with and without hyperthyroidism and (c) exophthalmic goitre.

O'Day,<sup>3</sup> encouraged by the improvement in sugar tolerance by thyroidectomy in four diabetic patients with exophthalmic goitre, operated upon the thyroid of two young patients with diabetes but with "no goitre symptoms" and reported restoration of normal carbohydrate tolerance in one, and nine ounces of carbohydrate a day in the other. Crile,<sup>4</sup> in a fascinating article on the "kinetic drive," described a series of operations on a patient with severe diabetes consisting of section of both cervical sympathetic

trunks, left suprarenalectomy and partial thyroidectomy with some improvement in sugar tolerance of a patient without evident thyroid disease. Fitz<sup>6</sup> was not particularly encouraged by the results of operation in this group of cases, although his observation led him to believe that "occasionally an operation may not only prolong life but be of greater benefit." He describes five patients with non-toxic goitre on whom thyroidectomy was done without mortality or benefit to the diabetes; six patients with exophthalmic goitre with one operative death, and six with adenomatous goitre with hyperthyroidism with one death. The diabetes was greatly benefited in one case of exophthalmic goitre and in three cases of adenomatous goitre. The results reported by Fitz and our own which confirm his findings in cases of diabetes mellitus and adenomatous goitre without hyperthyroidism as well as the experimental work of Allen lead us to the conclusion that the removal of a normal thyroid or a goitre without hyperthyroidism will not benefit the associated diabetes mellitus. Wilder<sup>1</sup> analyzes 15 cases of exophthalmic goitre and 23 cases of adenomatous goitre with hyperthyroidism associated with diabetes mellitus. Thirty-three of these cases were operated upon without a death and he concludes that thyroidectomy is almost always followed by a considerable gain in sugar tolerance. He finds that diabetes mellitus complicating hyperthyroidism does not exceed 1.1 per cent. being more frequent in the adenomatous group, 2 per cent., than in the exophthalmic group 0.6 per cent.

Rohdenburg<sup>6</sup> reports thyroidectomy in two cases of exophthalmic goitre with diabetes with improvement in the latter condition.

Dyas<sup>7</sup> reports three cases of exophthalmic goitre with glycosuria and probable diabetes treated by thyroidectomy without death. All cases remained sugar free following operation on unrestricted diet during a period of observation of several weeks. Unfortunately no blood sugar studies are given.

Buchanan<sup>8</sup> reports a case of diabetes mellitus complicated by hyperthyroidism with thyroidectomy and great improvement in carbohydrate tolerance.

Hubbell<sup>9</sup> briefly mentions a case operated upon with improvement in diabetes.

Falta<sup>10</sup> reports irradiation of the thyroid in six cases of exophthalmic goitre with diabetes and apparent improvement in the carbohydrate tolerance in four of them.

Glycosuria of a mild and transient nature occurring with hyperthyroidism has been described frequently in the literature and was encountered often in our experience. Fasting hyperglycæmia is a rare occurrence, although a high normal value is frequently seen. Alimentary hyperglycæmia following a test meal is frequent. There is no close relationship between the severity of the hyperthyroidism as determined by the basal metabolic rate and the hyperglycæmia. The curve obtained following sugar ingestion is that of the emotional type. In the University Hospital is a large diabetic clinic and all cases with hyperglycæmia are carefully studied there. The cases described in this report were referred to us from this group as cases of diabetes mellitus.

Since June, 1924, there have been 1150 cases of diabetes mellitus treated in this clinic. Of this number 12 cases were complicated by hyperthyroidism. All were treated by operation with one death. Eleven of these cases were adenomatous goitre with hyperthyroidism and one was a case of exophthalmic goitre. Many facts can be demonstrated by the report of a typical case:

CASE I.—(No. 160,668) *admitted in diabetic coma: insulin with prompt improvement, continuation of medical treatment for several weeks. Subtotal thyroidectomy. Apparent cure of diabetes.*

Mrs. S., housewife, age thirty-one, had increased thirst and polyuria for two months

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with loss of 15 pounds in weight associated with a moderate degree of nervousness and palpitation. One week before entrance she felt drowsy, became irrational and was brought to the hospital for treatment. Examination showed confused mental state, Kussmaul hyperpnoea, sweating, a small goitre and tachycardia. She was considered to be in extremis. The urine contained large quantities of sugar and the acetone bodies. The plasma  $\text{CO}_2$  combining power was 24 volume per cent. The blood sugar 267 mgm. per 100 c.c. She was treated with the usual anti-coma methods with considerable improvement for several days. It was then more clearly seen that there was a definite nervousness, tachycardia and sweating and hyperkinesis. A basal metabolic rate was

### CHART I

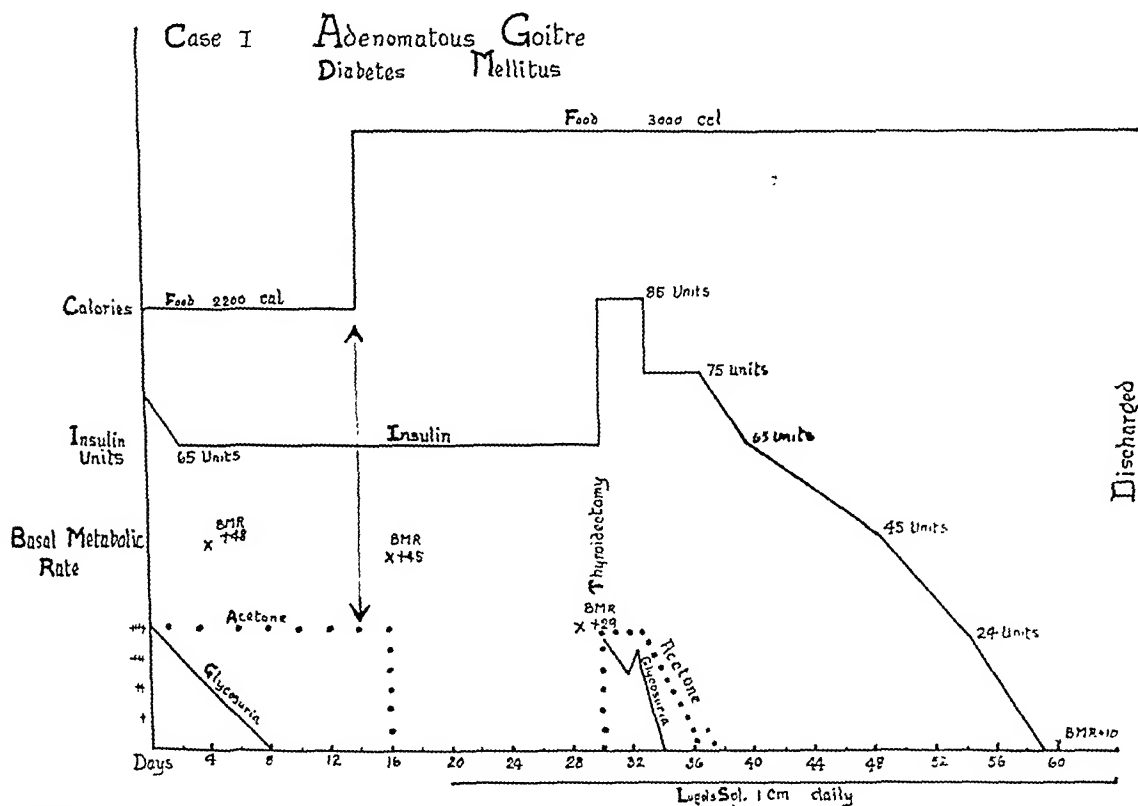


CHART I.—This chart illustrates the effect of diet on acidosis; and of operation on carbohydrate tolerance, basal metabolism, insulin requirements, and acidosis.

45 per cent. plus. She was treated with a diet of protein 55, fat 170, carbohydrates 45, supplying 2200 calories and 65 units of insulin were required daily. She immediately became sugar free except for a faint trace. Diacetic acid remained in the urine in large amounts. The diet was changed to protein 60, fat 275, carbohydrate 75, supplying 3000 calories and the urine became acetone free. After seventeen days of study and treatment she was given compound solution of iodine, one c.c. daily for nine days with a resulting drop in the basal metabolic rate to 29 plus. Subtotal thyroidectomy was done and followed by an uneventful convalescence except for a glycosuria and acetonuria for four days. The insulin dosage was gradually reduced so that on the twenty-third post-operative day she remained sugar free for the first time without insulin on a diet of 3000 calories. She was discharged on this diet and has gained steadily in weight and strength. She has an occasional transient glycosuria. The glucose tolerance curve, typical of diabetes mellitus before operation did not vary essentially following it.

This case illustrates well the possibility of the restoration to an approximately normal condition of a moribund patient with diabetes mellitus. The progress of the case is shown graphically in Chart I. The chief factor, leading to permanent improvement by operation, after the abolition of the acute

acidosis was the recognition of the presence of hyperthyroidism. This was not at once apparent since the goitre was very small and the symptoms of tachycardia and nervousness were attributed to the acidosis. Its recognition also gave an important aid in the dietary treatment, as it can be seen in Chart I that a high grade of acetonuria persisted for days after glycosuria had ceased. It could be predicted after the determination of the metabolic rate that the acidosis would disappear by raising the total number of calories, since the original diet was based on a normal metabolic rate and neglected

TABLE I.

*Demonstrating the Great Improvement in Hyperthyroidism and Carbohydrate Tolerance Effected by Thyroidectomy.*

Case No.	Admission weight	Weight loss in pounds	Time in months	Initial basal metabolism	Pre-operative basal metabolism	Post-operative basal metabolism	Days of iodine	Pre-operative insulin daily in units	Pre-operative diet in calories	Post-operative insulin discontinued	Post-operative diet
1	136	35	8	55	40	16	8	None	2400	3 days	2400
2	125	45	?	49	33	3	12	U.13	2400	25 days	2400
3	115	40	?	54	36	2	21	U.45	2400	18 days	3010
4	114	15	2	48	29	10	9	U.65	3000	22 days	3000
5	113	34	6	49	25	13	20	U.36	2500	7 mos.	2500
6	100	55	11	29	29	6	—	None	House Diet	16 days	2400
7	90	42	3	75	57	—	41	U.90	3000	—	
8	105	64	18	33	8	2	—	None	2330	5 days	2400
9	108	57	10	22	14	2	—	None	2400	7 days	2400
10	125	20	5	72	57	12	13	U.40	3000	15 days	2400
11	106	30	6	45	38	4	19	U.108	3000	29 days	
12	90	17	3	63	33	7	22	U.50	3000	16 days	2400

the 50 per cent. increase in the basal rate that was present. She was living on her body tissues and the calories provided by her fats were insufficiently covered by glucose to be completely burned. As soon as her quantitative caloric requirement was met, the acidosis disappeared. It is especially noteworthy that in the adequate diet the high fat ratio of the diet was maintained. Thus in the diabetic patient an increase of the general metabolism must be met by an adequate diet for the caloric requirements of the body.

Following thyroidectomy there occurs an immediate but brief increase in the metabolism. With all cases there was a mild or moderate glycosuria and acidosis lasting from four to seven days following operation. This indicates the need for more calories in the form of glucose and an increase



in the amount of insulin at this time. After operation, when the basal metabolic rate has dropped to normal, there is a marked increase in the carbohydrate tolerance. In all cases in the series, insulin, if needed before operation could eventually be dispensed with even with a high caloric diet. This was possible within one month after operation with the exception of Case V, in which the insulin though much reduced could not be entirely dispensed with for seven months. This patient was pregnant in addition to having diabetes mellitus and hyperthyroidism. This improvement in function is well shown in Table I. It must be emphasized that the diabetic state is not cured by thyroidectomy but is improved to such an extent as to simulate a cure. The glucose tolerance tests following the post-operative improvement of function in our series were of the diabetic type. In many of the cases careful dieting had to be followed after operation for an indefinite period.

It will be seen from Table I that two patients were in coma at the time of entrance to the hospital. These cases offer no unusual difficulties either in diagnosis or treatment. Of greater interest to the surgeon is the onset of diabetic coma following thyroidectomy in a supposedly non-diabetic patient. As already stated the entire carbohydrate metabolism is upset by hyperthyroidism and especially by the severe but transitory exacerbation following operation, so that a mild or unrecognized diabetic may have a dangerous and stormy post-operative course. This is illustrated by Case II.

CASE II.—(No. 124,843.) *Adenomatous goitre; mild glycosuria on one occasion before operation. Subtotal thyroidectomy followed by diabetic coma on second post-operative day. Medical treatment. Cure.*

Mrs. B., a housewife of fifty-eight, entered the surgical ward for treatment of goitre and nervousness of three years' standing. She was overiodized before entrance by use of a patent medicine with accentuation of all symptoms during the previous four months. Loss of fifty-eight pounds in ten months. Increased thirst for one year. Examination showed an emaciated elderly woman with an adenomatous goitre of moderate size, arteriosclerosis, pulmonary emphysema, cardiac enlargement and compensated myocardial disease. Basal metabolic rate plus 29 per cent. She was treated with bed rest and a high caloric diet for two weeks. On one occasion there was a moderate glycosuria but on three other examinations the urine was sugar free. The glycosuria was regarded as of the transitory type seen in simple hyperthyroidism and the carbohydrate metabolism was not studied. Subtotal thyroidectomy was done unaware of the presence of diabetes. On the day following the operation she became comatose, developed deep respirations, an acetone breath and a severe glycosuria, acetonuria and hyperglycæmia were demonstrated. She was treated with large doses of insulin and glucose given intravenous with restoration to a satisfactory state. After this 45 units daily of insulin were required for one week. On the eighteenth post-operative day insulin was discontinued and she tolerated a house diet of 2500 calories without glycosuria.

This case demonstrated the need for a careful investigation of the carbohydrate metabolism in all patients with hyperthyroidism and glycosuria. We believe it important in these cases to make a quantitative determination of the excreted sugar on a known diet and of the blood sugar with the standard glucose tolerance test in these cases.

Another complication which arose in the treatment of one of these cases was the confusion of diabetic acidosis with its exaggerated hyperpnœa, cya-

nosis and mental obtusation with tracheal obstruction. This is illustrated by Case III.

CASE III.—(No. 16,518.) *Severe diabetes and hyperthyroidism. Diabetic coma on two previous occasions. Difficulties in dietary management. Subtotal thyroidectomy. Diabetic coma resembling tracheal stenosis; tracheotomy, broncho-pneumonia, death.*

Mrs. E., a housewife of forty-four, had noticed thyroid enlargement for eleven years with thyroidism for the past twelve months. Two months before entrance she had polydipsia and polyhagia. Diabetic coma occurred with treatment by local physicians who were later unable to control diabetes. She had lost forty-two pounds in four months. Examination showed an emaciated, very nervous woman with hyperpigmentation of the skin and a large solitary adenoma of the thyroid. Basal metabolic rate plus 90 per cent. Typical diabetic glucose tolerance curve. CO<sub>2</sub> combining power of plasma 30 volumes per cent. Intense glycosuria and acetonuria. She was placed on a diet of 2600 calories with 100 units of insulin daily. There was considerable nausea, vomiting, diarrhoea, epigastric pain with attacks of dyspnoea and precordial distress. The urine could not be kept consistently free of acetone or glucose. She developed broncho-pneumonia which added to the difficulties of treatment but which cleared up in twelve days. Eventually she began to gain weight on a diet of 3000 to 5000 calories with large doses of insulin. The compound solution of iodine was given, one c.c. daily for forty days. The basal metabolism then had fallen to plus 57 per cent. and she was less nervous. A subtotal thyroidectomy was done easily and rapidly under ethylene anaesthesia. On the evening of the operation the respirations became labored and she became cyanotic and comatose. An emergency tracheotomy was done by the house surgeon without relief of symptoms. The subsequent administration of glucose and insulin restored the breathing to a normal state. Bronchopneumonia again developed and she died in four days. Autopsy showed a chronic atrophic interstitial pancreatitis; bronchopneumonia; diphtheritic infection of wound; mediastinitis.

This experience, occurring as it did in this series, is recorded with no great feeling of pride to demonstrate the need of wise judgment to prevent confusion between two superficially similar conditions each demanding immediate action. More careful and discriminating clinical observation would undoubtedly disclose the true situation. The important distinction between the two types of respiratory difficulty is the presence of stridor with laryngeal narrowing in the obstructive respiratory condition.

#### SUMMARY OF CASES \*

CASE I.—A Jewish woman of fifty-four, complaining of headaches and hot flashes; symptoms of hyperthyroidism for five months and diabetic symptoms for two months. Examination showed nervousness, an adenoma of the thyroid, and oedema of the ankles. Blood pressure  $\frac{170}{88}$ . Urine showed a moderate glycosuria and acetonuria on entrance.

Secondary polycythemia. Typical diabetic response to glucose tolerance test before and after operation. Pathological report of thyroid: Multiple adenomas with abundant colloid.

CASE II.—An American woman of forty-six with latent syphilis, hyperthyroid symptoms of one year's duration, had had a moderate diabetes for eighteen months. Coma one week before entrance for forty-eight hours. Blood sugar on entrance 0.200 grams. Diabetic glucose tolerance curve. Diphtheria three weeks after operation. Thyroid pathology: Adenomatous goitre.

CASE III.—An American woman of fifty-five had a large goitre for thirty years with hyperthyroid symptoms of two months' duration. Glycosuria found on routine examina-

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\* These cases correspond by number with cases in Table I.

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tion. Myocarditis with auricular fibrillation. Lenticular opacities. Fasting blood sugar 0.217 grams. Typical diabetic glucose tolerance response. Pathological report: Adenomatous goitre with abundant colloid.

CASE IV.—See text, Case I.

CASE V.—An American woman of thirty-eight had a goitre for seventeen years, diabetes mellitus nine years; hyperthyroid symptoms one year. Hypertension. Two months' pregnancy at the time of operation. Glucose tolerance of the diabetic type. Excreted 26 grams of glucose on 2400 calorie diet without insulin. Pathological report: Multiple adenomas; localized patches of lymphoid hyperplasia. This patient needed insulin until after parturition to cover a high maintenance diet. This was then discontinued. She has gained 26 pounds in one year.

CASE VI.—See text, Case II.

CASE VII.—See text, Case III.

CASE VIII.—A Jewish housewife of fifty-two had a goitre for ten years with diabetic symptoms for eighteen months. Severe glycosuria on entrance with a moderate acetonuria. Auricular fibrillation and chronic myocarditis. Evidence of manic depressive psychosis while in the hospital. Fasting blood sugar 0.160 grams. Typical diabetic glucose tolerance response. Pathological report: Adenomatous colloid goitre.

CASE IX.—A male American paint sprayer of fifty-three had symptoms of diabetes for one year with nervousness. Onset was of rather severe hyperthyroidism five months ago. Neuroretinitis. Intense glycosuria on house diet. Fasting blood sugar 0.166 grams. Typical diabetic glucose tolerance curve both before and after operation. Pathological report: Graves' constitution adenomatous thyroid.

CASE X.—An American housewife of fifty-nine had a goitre for many years; nervousness, tachycardia, fatigue for three months. Examination showed an orange-sized adenoma of the left thyroid lobe, cardiac enlargement, signs of hyperthyroidism with marked tracheal compression. Typical diabetic glucose tolerance response. Intense glycosuria on a house diet. Pathological report: Colloid goitre with large degenerating adenomas. Auricular fibrillation for one week following thyroidectomy but an otherwise uneventful convalescence.

CASE XI.—An American housewife of forty-five complained of headache, loss of weight and slight œdema of the extremities. Mild hyperthyroidism for six months. Examination showed a large adenoma of the thyroid; neuroretinitis with arteriosclerotic changes. Typical diabetic glucose tolerance curve. Intense glycosuria and acetonuria on entrance. Pathological report: Adenomatous goitre.

CASE XII.—An American schoolgirl of sixteen had symptoms of diabetes for three months, with severe symptoms of hyperthyroidism in the same period following a severe emotional upset. Examination showed a chronic bilateral otitis media in addition to the classical picture of Graves' disease. Diabetic glucose tolerance curve. Marked glycosuria on entrance. Pathological examination of thyroid; exophthalmic goitre.

### SUMMARY

1. Great improvement of carbohydrate function follows thyroidectomy in the syndrome of hyperthyroidism and diabetes mellitus. This is probably never a "cure" of the latter condition.

2. Thyroidectomy does not benefit carbohydrate tolerance in non-toxic thyroid states.

3. Glycosuria occurring in hyperthyroidism is an indication for study of the carbohydrate metabolism. Coma may result as a post-operative complication of thyroidectomy consequent upon an unrecognized coexistent diabetes mellitus.

4. Care must be taken to rule out diabetic coma in cases of suspected tracheal obstruction.

5. Acidosis frequently results in hyperthyroidism with diabetes due to an insufficient number of calories provided in the diet.

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# INTRAPLEURAL PRESSURE IN POST-OPERATIVE ATELECTASIS

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In 1908, Pasteur<sup>1</sup> called attention to massive collapse of the lung as a not infrequent complication of major operative procedures. Since that time numerous articles dealing with the condition have been published. The literature has been extensively reviewed by Scott,<sup>2</sup> Churchill,<sup>3</sup> Jackson and Lee,<sup>4</sup> and others, and for a complete résumé of the subject the reader is referred to their papers. In spite of the excellent clinical studies which point out the diagnostic criteria, the etiology of the condition remains obscure and its experimental reproduction is wanting.

The purpose of this article is to call attention to the value of estimating the intrapleural pressure as a diagnostic aid, and as a means of differentiating post-operative atelectasis from other pulmonary complications. So far as can be determined, no previous estimations of the intrapleural pressure in this condition have been recorded in the literature.

Normally the intrapleural pressure varies from minus 9 mm. of mercury on inspiration to minus 2 mm. of mercury on expiration.<sup>5</sup> Expansion of the alveolar spaces is due to the pull of this negative pressure. Should the pressure become positive, as in pneumothorax, collapse of the lung results with displacement of the mediastinal contents into the contralateral area of lesser pressure. However, in atelectasis, or massive collapse, the mediastinal contents are displaced *toward* the side of the lesion. This displacement is the most characteristic physical sign, and together with the marked narrowing and retraction of the intercostal spaces, indicates a very definite lowering of the intrapleural pressure. Such a lowering is thought to be secondary to the lowering of the intrapulmonic pressure through deflation and collapse of the lung. The exact cause of this deflation is still a matter of conjecture, and may be due to one of several causes. Each of the cases here reported is apparently due to a different cause; the first to bronchial plugging by mucus, the second

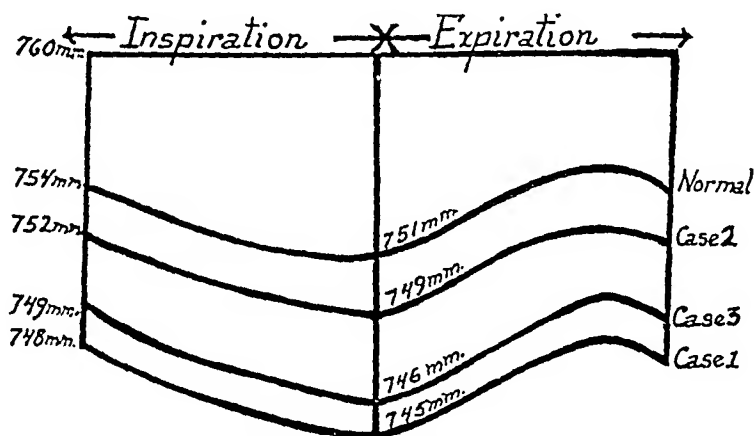


FIG. 1.—Diagram representing the lowered intrapleural pressures in three cases of massive atelectasis, as compared to the normal pressure.

to some reflex nervous phenomenon, and the third to bronchial occlusion by a metastatic growth.

CASE REPORTS.—CASE I.—I. J., a negro male, age eighteen, entered the Emory University Division of the Grady Hospital, April 13, 1926.

There was nothing of importance in his history except the story of a right inguinal hernia of three years' duration. Twenty-four hours before admission to the hospital this hernia became caught in the scrotum and the patient was unable to reduce it.

Immediate operation was done under ether anaesthesia. The anaesthetist noted a large amount of bronchial mucus and the necessity of deep anaesthetization to secure

relaxation. Incision over the hernial mass disclosed an empty sac, with dense infiltration and oedema of the tissues. The intestines were red and inflamed, but there was no evidence of gangrene. The hernial defect was repaired after the manner of Bassini.

On the day following the patient's temperature was 104° F., pulse 120, respiration 30. No examination of the chest was recorded.

Forty-eight hours after operation the house officer noted diminished respiratory excursions on the right side with dullness and diminished tactile fremitus. The left chest was normal. Temperature 103° F., pulse 132, respirations 36.

On the third day post-operative it was evident that there was something more than a pneumonia present in

FIG. 2.—Case I. Röntgenogram, three days after operation. The entire right side is clouded, and the displaced trachea with its bifurcation is sharply contrasted. The heart is so displaced to the right that the left border cannot be seen. There is a definite narrowing of the intercostal spaces on the right side.

the patient's chest. He was inclining toward the right side, and when placed straight in bed would quickly resume that position. There was a definite retraction and narrowing of the right intercostal spaces, and expansion was limited on that side. The right chest was flat to percussion except in the upper part near the sternum where the note was that of high-pitched wooden tympany. In this area the breathing was amphoric, but elsewhere on the right side the breath sounds were absent or distant. Tactile fremitus and whispered voice were absent except over the area of amphoric breathing, where both were increased. The heart was entirely on the right side, with the left border corresponding with the left sternal margin. The right border of the heart and the liver dullness could not be differentiated from the dullness of the lung. A diagnosis of post-operative atelectasis was made and the diagnosis confirmed by röntgenogram (Fig. 2).

During the first week after the operation the condition of the patient remained unchanged, except for the expectoration of large amounts of thick, foul, tenacious sputum.

April 24, eleven days after the operation, the intrapleural pressure was estimated. A needle attached by a rubber tubing to a U-tube manometer containing water was

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used.\* On introducing the needle into the right pleural cavity the pressure fell to what was equal to minus 12 mm. of mercury and on inspiration the water in the tube rose to an equal of minus 15 mm. of mercury and started over the proximal limb of the tube (Fig. 1). The pressure on the left side ranged from minus 6 to minus 8 mm. of mercury.

The patient continued to expectorate a large amount of thick tenacious sputum, especially when placed on his left side. April 26, fourteen days after operation, there were signs of beginning aëration and a return of the heart to its normal position.

By April 30 his temperature, pulse and respirations were normal, and he was discharged from the hospital on May 21, thirty-one days following operation. His

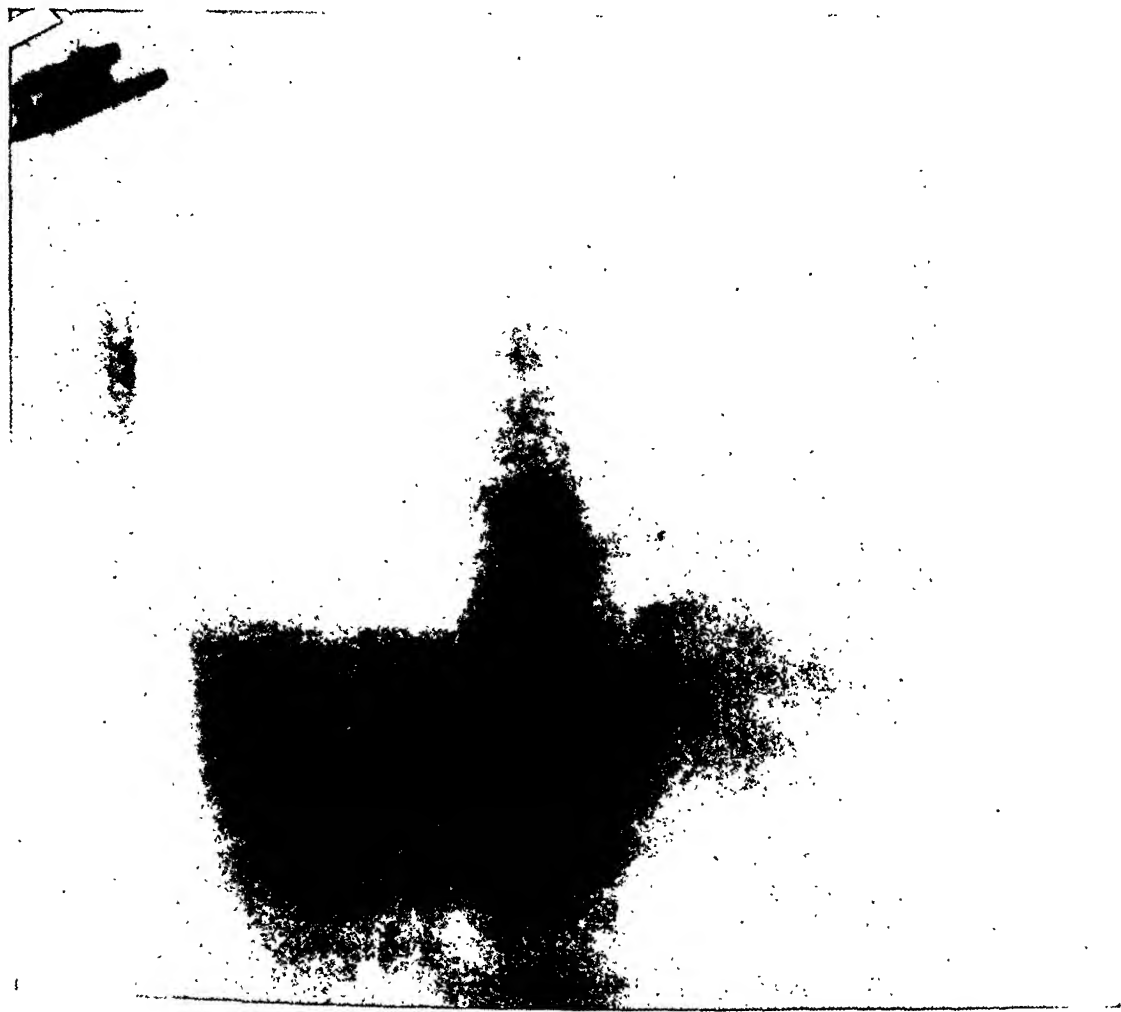


FIG. 3.—Case II: Röntgenogram, four days after dislocation of shoulder. There is displacement of the mediastinal structures to the left, with narrowing of the intercostal spaces.

wound healed without infection and three months later examination showed his chest to be normal in every respect.

CASE II.—A. R., a white section foreman of forty-four, entered Wesley Memorial Hospital, October 18, 1926. Three days before, as a result of a railroad accident, he suffered a fracture-dislocation of the left humeral head and a fracture of the left tibia. There was no evidence of trauma to the chest other than a superficial bruise in the axilla. There was no respiratory difficulty, no cough, and no cyanosis, but the left

\* In cases of increased positive pressure due to pneumothorax it has been shown by Graham<sup>6</sup> that the pressure in the contralateral side is increased. For that reason an estimation of the pressure was made on both sides in the three cases here reported. The readings have been translated into terms of mercury since estimations are usually recorded in that manner.

side of the thorax was markedly retracted, and the intercostal spaces were hollowed and narrowed. The apex of the heart was in the left anterior axillary line, and the trachea was displaced toward the left. The lung showed impaired resonance on percussion, and the breath sounds were weak and distant (Fig. 3).

The intrapleural pressure was estimated as in Case I and found to be minus 8 mm. of mercury on expiration and minus 10.5 mm. on inspiration on the affected side. On



FIG. 4.—Case III. Röntgenogram showing atelectasis of the left lung due to metastasis from a fascial sarcoma of the thigh.

the non-affected side the pressure ranged from minus 6 to minus 8 mm. of mercury.

Three days later the left chest had regained its normal shape and the mediastinal structures had returned to their normal position. The resonance of the lung had returned and the breath sounds were normal.

Ten days later an open reduction of the humeral head was done under ether anaesthesia and was not attended by any pulmonary complications.

CASE III.—A. B., a negress of thirty-nine, entered the Emory University Division of the Grady Hospital, December 2, 1926. A year previously a small nodule had been removed from the posterior surface of the right thigh. In August, 1926, there was a recurrence of the growth, which was removed under local anaesthesia, and in November, 1926, a third

excision was done. At the time of entrance to the hospital (December 2, 1926) there was a cauliflower mass about 8 cm. in diameter on the posterior portion of the right thigh just below the gluteal fold. It was partially necrotic and infected. (Biopsy showed a round-cell sarcoma.)

The patient had lost forty-five pounds since the onset of her illness a year before admission. The liver was enlarged and thought to be the seat of metastasis, although the edge was smooth. There were no other signs of metastasis except in the lungs.

On inspection the left side of the chest was definitely collapsed and the interspaces narrowed. On inspiration there was only slight movement on the left. The whole left lung was dull to percussion. The heart was displaced to the left side with the apex impulse in the sixth space, 2 cm. outside the mammary line. Breath sounds were weak and distant. The right chest was normal in every respect.

X-ray January 3, 1927, showed a definite atelectasis of the left lung with narrowing on the intercostal spaces and displacement of the heart to the left side (Fig. 4).

Estimation of the intrapleural pressure was made January 6, 1927. On the left side the pressure ranged from minus 11 mm. of mercury on expiration to minus 13.5 mm. on inspiration. The pressure on the right, or non-affected side, was practically the same.



## INTRAPLEURAL PRESSURE IN POST-OPERATIVE ATELECTASIS

Three other X-ray examinations of the chest were made, and all showed practically the same degree of collapse of the lung, but the amount of aëration varied to some extent.

It was thought that the atelectasis in this case was due to bronchial obstruction from a metastatic nodule.

At the time of discharge from the hospital, March 15, 1927, there was no change in the physical signs of the lungs.

*Comment.*—The presence of a marked reduction in the intrapleural pressure in three cases of massive atelectasis of the lungs is in keeping with the physical signs. The extreme displacement of the mediastinum toward the side of the lesion indicates a lowering of the pressure on the affected side, such as is found in no other pulmonary condition. The rapid pulse, cyanosis, and dyspnoea occurring in some cases may be due to mediastinal displacement. It is probable, therefore, that the introduction of air into the thoracic cavity in order to raise the pressure, and so bring the mediastinal structures back to their normal position, may be of therapeutic value.

### CONCLUSIONS

1. Pulmonary atelectasis is not infrequently a post-operative complication, as is shown by the increasing number of reported cases.

2. There is a definite and well marked lowering of the intrapleural pressure as shown by the manometric readings in the cases here reported, and by the physical signs of mediastinal displacement and retraction of the ribs and intercostal spaces.

3. The estimation of the intrapleural pressure is advocated as a diagnostic method, since in no other condition is there a lowering of this pressure.

4. It is suggested that the introduction of air into the pleural cavity of these cases showing marked cyanosis and dyspnoea may be of therapeutic value in bringing the mediastinal structures back to their normal positions.

Since this paper was written another case of post-operative atelectasis has been observed in which the intrapleural pressure ranged from minus 11 mm. of mercury on expiration to minus 14 mm. on inspiration.

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# CALCULOUS OBSTRUCTION OF THE COMMON AND HEPATIC BILE DUCTS\*

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Most clinics in the past decade have witnessed a marked decrease in their general surgical mortality. The death rate in some diseases has been reduced so greatly as to be almost negligible, but in others, the most recent advances in operative preparation and technic have not been productive of such excellent results.<sup>1</sup> While remarkable progress has been made in the surgery of the biliary tract, the mortality and morbidity are unduly high in certain groups of cases, and calculous obstruction of the common and hepatic bile ducts still remains a formidable foe of the average surgeon. A case analysis of this particular group was undertaken with the hope that a free and open discussion might shed further light on the factors responsible for the high death rate.

This study is based on ninety-two cases of primary and twenty-two secondary cases of calculous obstruction of the common and hepatic bile ducts. These were gathered from one thousand, two hundred and eighty ward cases of gall-bladder and biliary duct disease exclusive of stricture and malignancies operated at the Mt. Sinai Hospital, New York, from 1917 to 1926. Eighty-five per cent. of these were accompanied by lithiasis, and nine per cent. of this number were complicated by the presence of stone in either or both of the common and hepatic bile ducts. A review of Table I will demonstrate that the presence of acute infection increases the mortality more than twofold, from 2.7 to 7 per cent., but when this is coupled with a calculous obstruction of the common bile duct, the death rate leaps to twenty-three per cent. (Table I.)

The gall-bladder in this group when present and visualized gave evidence of marked chronic inflammatory change in every case but one, a case of intrahepatic calculi. As a rule it was thickened, dull gray in color, often intimately adherent to adjacent viscera, occasionally completely hidden beneath a veil of firm dense adhesions. Recent acute inflammation was present in twelve cases. The size of the gall-bladder varied, larger than normal in half, and contracted in the remainder, with calculi absent in over a third of the cases.

Most common duct stones unquestionably originate from the gall-bladder where they are formed as the result of bile stasis, hypercholesteræmia and infection. A few maintain,<sup>2</sup> however, that the primary foci may be the smaller bile radicles of the liver. But the disease of the gall-bladder and its ducts are no longer considered isolated entities, but rather an expression of hepatic

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\* Read before the New York Surgical Society, October 12, 1927.

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pathology. In fact, the degree of cholecystitis and cholelithiasis might be looked upon as a mirror reflecting liver change,<sup>3</sup> for all gradations of inflammation have been noted from leucocytic infiltrations of the smaller bile passages to acute yellow atrophy.<sup>4</sup> It has been shown that as a result of gall-bladder damage there is a tonic spasm of the sphincter of Oddi with a general hydrohepatosis<sup>5</sup> and atrophy of liver tissue with scar tissue replacement. In a third of the cases the liver was enlarged and in many cirrhosis was present. While the margin of safety of the liver is undoubtedly large,

TABLE I.

*Summary of 1280 Operated Cases of Biliary Tract Disease. (Exclusive of Malignancy and Duct Reconstruction.)*

Type of operation with percentage mortality	Diagnosis	No.	Percentage mortality	
Cholecystectomy in 1155 cases with percentage mortality of 3.4	Acute cholecystitis	85	4.7	Aver. % mortality 3.6
	Chronic cholecystitis	110	1.8	
	Acute cholecystitis and cholelithiasis	138	9.4	
	Chronic cholecystitis and cholelithiasis	833	2.7	
Cholecystostomy in 11 cases with percentage mortality of 18.0	Acute cholecystitis with common duct stone	1	0.0	Aver. % mortality 23.6
	Chronic cholecystitis with common duct stone	35	40.0	
Cholecystectomy in 82 cases with percentage mortality of 23.1	Acute cholecystitis, cholelithiasis and common duct stone	11	18.0	Average per cent. mortality 5.4
	Chronic cholecystitis, cholelithiasis and common duct stone	49	17.0	
	Common duct stone	18	16.0	
Cholecystostomy in 5 cases with percentage mortality of 20.0	Acute cholecystitis, cholelithiasis and common duct stone	11	18.0	Aver. % mortality 23.6
	Chronic cholecystitis, cholelithiasis and common duct stone	49	17.0	

a certain degree of deficiency exists which is usually associated with renal incompetence. Frank cases of gall-bladder disease with azotemia and abnormal urinary findings should immediately suggest the probability of profound liver dyscrasia.

It is rather difficult to visualize the migration of calculi from the gall-bladder when the diameter and the spiral valves of the cystic duct are considered. These, in most instances, must reach the larger ducts in rather a small form, and these increase in size, aided by the products of biliary stagnation. The majority of these potential calculi are probably washed through the ampulla and rarely occasion clinical symptoms. In very rare cases, only twice in the series, liver calculi<sup>6,7</sup> may be the source of common duct obstruction, but this particular genesis must be extremely uncommon, excepting for some hepatic duct stones. Primary choledochal stone formation is most unlikely, especially when one considers the small number of common duct stones developing after the great number of cholecystectomies performed. In fact, most secondary operations for common duct calculi

prove that the surgeon was either directly or indirectly responsible for their presence by committing two omissive sins. Failure to properly probe and palpate the biliary ducts, and forcing small calculi through a patent cysticus while performing a retrograde cholecystectomy, account for practically secondary choledochal stones. In twenty-two secondary cases no evidence could be adduced to show that the calculi found were formed in the common bile duct with the exception of the soft pultaceous material made from inspissated bile in one case.

The degree of dilatation and the contents of the obstructed bile varied considerably. The diameter of the choledochus ranged from normal to that of the small intestine. The contents regularly showed no evidence of frank infection, although culture showed signs of bacterial activity. Pus was present only twice, and white bile once. The calculi varied from gravel to the size of hazelnuts, and from one to fifty in number. In eighty-four cases in which the stones were confined solely to the choledochus, the mortality reached twenty-one per cent., in twenty in which the hepaticus too was obstructed, the death rate was thirty per cent. In four instances of hepatic calculi there were no deaths. In forty-eight cases in which stones were solitary, the mortality was eighteen per cent., while in fifty cases in which they were multiple, the death rate was twenty-five per cent. While the degree of obstruction produced by a solitary calculus is not proportionate to its size, drainage naturally is obstructed more effectively and completely when multiple stones block several areas of the larger duct system of the liver. This increases back pressure and with it comes greater absorption resulting in increased toxicity, and higher mortality.

Jaundice, the main product of obstruction, was not always present, yet at some time in the course of the disease it complicated the majority of cases. When present it is equivalent to probable liver dysfunction, potential kidney injury and a variable degree of tissue devitalization. It means a general absorptive systemic poisoning through a retention of those waste products and bacteria ordinarily eliminated through the bile. This cannot be expressed clinically in terms of hemorrhage alone. Even though this factor can now be eliminated to a large extent, the mortality is still high because the indelible effects of irreparable tissue injury augmented by years of repeated insult remain.

It is amazing how long the average patient will endure the suffering of gall-bladder disease and tolerate purposeless medical treatment. The delay is costly, and the dangers of operation seem to increase directly with the length of time that surgery is postponed. The average number of weeks during which these patients complained of their symptoms was more than two hundred. In other words, they were ill continuously or intermittently for almost four years. Those who survived operative intervention suffered about three years, one hundred and seventy-five weeks, while those who succumbed delayed their operation for two hundred and sixty-four weeks, or more than five years. The deleterious effects of this intermittent bilirubi-

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næmia and infection over prolonged periods are certainly illustrated by these statistics, and even more poignantly by those which follow. Cases which had a smooth convalescence were icteric nine days prior to operation, those which developed post-operative complications averaged eleven days of jaundice, and those which succumbed had been icteric twenty-four days prior to surgical intervention. The mortality in those with complete obstruction was sixty per cent., while the death rate of those in which jaundice was not apparent either clinically or chemically was nine per cent.

TABLE II.

Decade	Number	Deaths	Percentage mortality
20-29	9	1	11
30-39	25	4	16
40-49	30	7	23
50-59	35	10	29
60-69	14	4	29
70-80	1	1	100

TABLE III.

Sex	Deaths	Percentage mortality
Males 18.....	6	33
Females 96.....	21	22

Common duct obstruction in cholelithiasis is naturally more common among women and most frequent clinically during the fourth and fifth decades of life. These statistics, and the influence of age on mortality may be seen in Tables II and III. The history as a rule is one of gall-bladder disease characterized by upper abdominal distress and innumerable attacks of typical colic accompanied in most instances by the intermittent appearance of transient jaundice, dark urine, clay-colored stools, and more rarely by chills and fever. While the symptoms may exist for thirty years, or be as recent in onset as a week, the average period of complaint is about four years. In secondary cases, symptoms may recur from a few months to twenty-two years after operation, the average period being eight years. However, the appearance of pain often of a colicky nature, occasionally accompanied by jaundice, and less frequently by chills and fever, is not always indicative of common duct stone. Following any cholecystectomy, there is a certain degree of compensatory dilatation of the ducts,<sup>8</sup> probably an increase in the mucus, besides the infection still resident in the liver or pancreas, or both.<sup>9</sup> These are sufficient causes for the symptoms. In the period of 1917 to 1926, there were twelve cases, not included in this series,

admitted following cholecystectomy, complaining of the condition described. Eight cleared spontaneously with rest in bed and forced fluids, and four were discharged against advice. On the other hand, the absence of jaundice and its complications is no proof that the choledochus and its branches are free and unobstructed because more than eighteen per cent. of the patients gave no historical, physical or chemical evidence of icterus, and yet single or multiple ductal calculi existed. Icterus, however, was undoubtedly present at some time, but passed unrecognized. It was rarely progressive or intense, and in only five per cent. was the obstruction complete for a prolonged period. A deep icterus, increasing in intensity without pain should arouse suspicion as to the possibility of a carcinomatous occlusion arising in the choledochus,<sup>10</sup> ampulla of Vater, head of the pancreas or second portion of the duodenum. In this series, definite epigastric pain or right upper quadrant colic was present in one hundred and thirteen cases. One patient only gave a history of painless jaundice, but X-ray examination revealed a solitary calculus which operation confirmed as the cause of obstruction. Infection while probably universally present and insidious in its effects, did not always manifest itself clinically because biliary drainage was rarely completely blocked. Nineteen of the patients had temperature on admission and about twenty gave a definite history of severe shaking chills, but only a few presented the syndrome first described by Charcot. Infection severe enough to manifest itself by chills and fever is a grave complication and over fifty per cent. of these patients succumbed soon after surgical interference.

Physical examination showed the majority to be well nourished, only eighteen appearing as though they had lost weight, and about a third were described as "appearing acutely ill". It is this fair physical appearance which is most misleading, and constitutes the false threshold upon which most radical surgical intervention takes its footing. Jaundice usually of a mild degree was present in eighty-five and intense in only nine. The abdomen as a rule was soft and lax, in twenty-eight there was upper right quadrant rigidity of varying degree. The liver was enlarged in thirty-six cases and while the gall-bladder was reported as palpable in nineteen, exploration proved that only eight may have been sufficiently distended to be palpable, verifying the practical reliability rather than infallibility of Courvoisier's law.

The laboratory tests were not as important diagnostically as in determining operative indications and post-operative progress. The Meltzer Lyons test added but little in the differential diagnosis, and cholecystography because of its present dangers in the jaundiced was of small help. Liver function tests in these icteric individuals were found almost valueless. The Van den Bergh reaction which gave a quantitative estimation of the bilirubin in the blood was of inestimable value. The degree of jaundice is very deceiving clinically and this serum reaction readily sensitive to minute changes in the degree of bilirubinæmia, was a fairly reliable aid in judging its intensity. Its value as an indicator of obstructive and non-obstructive icterus was more academic than real. Bleeding and coagulation times usually prolonged

were extremely important as safeguards against hemorrhage, and a blood chemistry examination gave some indirect idea of liver and kidney function, but too much credence was never placed on normal figures for they were often found to be very misleading in the prognostication of the post-operative course.

The best time for operative interference always taxes surgical judgment. There is no doubt that patients are better risks when the blood bilirubinæmia is normal. There is always the possibility that the obstruction will be relieved spontaneously by the passage of the stone into the duodenum. In the ten-year period covered by this series, ten patients were provisionally diagnosed as suffering from calculous obstruction. The condition in eight subsided under conservative observation, the stone being recovered in the fæces of three. But the relief of obstruction clinically is no positive proof that the calculus has been eliminated because it may have subsided sufficiently to permit a freer drainage. If the degree of obstruction was constant or increasing as determined by daily Van den Bergh estimations, no time was lost in immediate exploration.

A routine standardized ante-operative preparation for these patients must now be regarded as paramount. Unfortunately, no plan of organized preparation was instituted in this series. The tissues should be liberally supplied with fluid, the alkaline reserve increased, and the liver sufficiently protected with glycogen through high carbohydrate diet, augmented, if necessary, by the rectal and intravenous administration of glucose solution. Should the sugar tolerance be low, it can easily be raised and controlled by the judicious administration of insulin. Hemorrhage usually can be effectively controlled by the use of calcium chloride intravenously,<sup>11</sup> supplemented, if necessary, by blood transfusion. This is excellent not only because it diminishes the tendency to bleed, but because it furnishes an internal stimulative meal.

In conditions such as these, inhalation anæsthesias have been repeatedly proven to be the added fatal insult.<sup>12,13,14</sup> There is no reason why these cases should not be satisfactorily explored under high spinal anæsthesia, and although the blood-pressure is apt to be low, it can be effectively maintained by hypodermic ephedrine. The few cases in this series operated under local abdominal wall block were usually the sickest, so that the mortality of 33 per cent. is no indication of the efficacy of this form of anæsthesia. (Table IV.)

TABLE IV.

Anæsthesia	Number	Deaths	Percentage mortality
Gas and ether.....	99	21	21
Gas and oxygen.....	3	1	33
Gas, oxygen, and ether....	6	3	50
Local.....	6	2	33

The best operation for calculous common duct obstruction is the prophylactic. Each case of cholecystitis or cholelithiasis, whether presenting icterus or not, should be considered a potential choledocholithiasis. If the common bile duct and its branches were manually palpated in a routine way, the morbidity of recurrence would be greatly lessened. The choledochus should be explored especially when the gall-bladder and cystic duct contain many small stones, or the wall of the common duct is thickened, or a history of fever, chills, and icterus has been obtained, and in secondary explorations for pain following cholecystectomy. The advisability of probing the common duct in cases without a history suggestive of common duct stone is debatable, and it is barely possible that post-operative biliary leakage may come from a fistula inadvertently made by a fine probe penetrating the walls of the choledochus. It is true that the palpating fingers may not feel stones, especially in the retroduodenal portion of the choledochus, but the probe too may pass them unnoticed, as the autopsy protocols in six cases will certify. Calculi left behind are often responsible for death because biliary obstruction still continues. It must be stated, however, that no matter how carefully and skilfully the operator palpates, and sounds the bile channels with probe, forceps and spoon, calculi may be left behind. Another safeguard worth employing is the temporary ligature of a patent cystic before attempting a retrograde cholecystectomy for multiple small calculi as suggested by Dr. Edwin Beer.

A common duct with calculi is rarely difficult to locate and isolate at a primary operation, but it should be adequately exposed before it is incised. When once stones have been located they should be held, if possible, until extracted, because calculi slipping back into a hepatic may never be recovered again. This happened twice and once led to disastrous consequences. A supraduodenal incision is best and safest for the removal of most calculi and was used eighty-nine times. Some surgeons preferred to dilate the cystic and thus express small choledochal stones, and if this was impractical, the duct was split open into the common or hepatic. This was done in nineteen patients, but in one fatal hemorrhage resulted. While this procedure is regularly innocuous, it is possible to injure the right hepatic or an aberrant branch of the gastroduodenal artery. Large impacted calculi which cannot be delivered through a supraduodenal incision may be crushed as was done once, but lithotripsy is quite apt to damage mucous membrane and fragments may remain to form nuclei for future stones. An impacted ampullary calculus occasionally may be forced into the duodenum, but a safer course is an adequate exposure of the retroduodenal portion of the duct by a Kocher mobilization so that the stone may be pushed supraduodenally and there extracted. If this is not feasible, an anterior duodenotomy, which was only necessary twice in this series, is preferable to a retroduodenal choledochotomy. There is always danger in this procedure of pancreatic duct injury and retroperitoneal infection from leakage, while a duodenum carefully



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sutured with the choledochal drainage kept away from the suture line, rarely results in fistula.

The question of common duct drainage is still debatable. It may either be completely sutured, or drained internally or externally. Each of these procedures has its strong adherents—each method claims the best results.

Dilatation of the ampulla followed by a complete suture of the common duct without drainage,<sup>15</sup> while apparently ideal, seems a dangerous procedure at best. It has been stated that the removal of drainage is likely to be followed by hemorrhage, that the loss of bile is detrimental to many, and that these wounds heal by secondary intention<sup>16</sup>—yet all of these conditions even if they do arise can be more effectively combated than a biliary peritonitis from leakage. The danger of acute biliary suppression from a too rapid and continued decompression of a distended duct system<sup>17</sup> arises more frequently in academic discussion than in clinical experience, although the conditions obtaining here are quite similar to those of urinary suppression following a suprapubic cystostomy for urethral obstruction. Suture of the choledochus with drainage to the suture line seems to possess no advantage to choledochostomy. If the region of ampulla has been probed, the reflex spasm of the sphincter of Oddi, together with the œdema and exudation incident to trauma, is almost sure to produce complete obstruction. The sutured duct soon yields to the increase of intraductal pressure and the presence of infection. Some surgeons have added internal drainage to primary suture to overcome this sphincteric spasm.<sup>18</sup> After dilatation of the ampulla with graduated bougies, a drainage tube is passed from the hepaticus into the duodenum, leaving the distal extremity sufficiently long so that it will eventually be removed by intestinal peristalsis. The method, while ideal as far as primary union of the duct and drainage of bile is concerned, seems open to too many possible complications if tube reconstruction of the biliary tract may serve as an example.

External drainage not only gives free vent to the products of the inflamed radicles of the liver, thus allaying the cholangitis, but it rests the pancreas, and if the retrojection of bile is responsible for some grades of pancreatitis, then that organ too shares in the benefit derived. Moreover, the opening of the choledochus is a safety valve through which additional calculi may be extruded, if any inadvertently remain. Stones were discharged in this manner in four cases.

When all angles of the drainage problem are considered, the external method whether used *via* the cysticus, choledochus or hepaticus, although imperfect, is the safest, and its end results are not bad enough to justify the more radical and dangerous procedures recently advocated.

The problem of the diseased gall-bladder, in any primary operation for calculous obstruction is a difficult one, because cholecystectomy is ordinarily indicated here as in most other cases. In this series of 1280 cases, the gall-bladder was removed in over 95 per cent. of the patients, and in about 85 per cent. of the ninety-two primary cases of common duct obstruction. But

there should be no routine procedure; each case should be decided individually. The reason for leaving the diseased gall-bladder is not that it may be necessary for anastomotic purposes should the choledochostomy result in stricture. This rarely happens if the common duct is drained properly. But presence of jaundice is the danger signal even though the patient may appear in good condition. It immediately converts a standardized routine procedure into an emergency which demands the simplest drainage operation to relieve the jaundice, choledochostomy. A dilated duct is usually easily identified, the calculi are ordinarily extracted without difficulty and a drainage tube inserted, but if this seems inadvisable because of technical difficulties or the precarious condition of the patient, cholecystostomy if the cystic is patent, must answer. An additional cholecystectomy while only adding fifteen to twenty minutes to the operating time, adds much more to the surgical shock, the possibility of hemorrhage and the likelihood of infection. It is this very triad which is responsible for most deaths. In the jaundiced, the oozing from the bed of denuded liver, while not sufficient to result in severe hemorrhage, contributes heavily to a stormy convalescence,<sup>19</sup> and the toxæmia increased by further absorption through the open lymphatics, is often sufficient to turn the tide against the patient. These gall-bladders which in thirty-five cases did not contain stones and were usually shrunken and atrophic, represented the end result of the local disease, and probably reflected the maximum of liver and kidney injury. The mortality in this particular group was 40 per cent. As far as the organ itself was concerned, it was silent; its removal was of little clinical importance but the cholecystectomy undoubtedly contributed to this fearful mortality. In a group of twenty-two secondary cases, simple choledochostomy was done in twenty-two and cholecystectomy added in only four. The mortality here was fourteen per cent. In spite of the fact that these secondary operations are technically more difficult because of the widespread and dense adhesions, shock and post-operative complications appeared less. The omission of cholecystectomy with its incident operative dangers may have been the dominant factor causing this decrease in operative mortality. Should future symptoms develop from a gall-bladder which was left, a subsequent operation can be undertaken. The multiple stage operation is never an indictment against surgical courage, or judgment. It certainly should be given a greater place of prominence in cholelithiasis complicated by common duct obstruction.

The causes of death in twenty-seven cases may be divided into the immediate, the intermediate, and the late. Shock and hemorrhage comprise the first, infection with hepatic and renal insufficiency the second, peritonitis, pneumonia and pancreatic asthenia the third. Twelve patients died of shock complicated in three instances by hemorrhage. Almost forty-five per cent. of deaths were due to an operative procedure of too great a magnitude under existing conditions. Eight deaths resulted from infection coupled with hepatic and renal insufficiency, a condition formerly known as cholemia. Six

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succumbed to a peritonitis, and other complications such as pneumonia and embolism.

The post-operative course was uneventful in about sixty patients, and stormy in twenty-seven. The complications were caused by the effects of moderate liver and kidney insufficiency, resulting in persistent vomiting "cholemic" hemorrhages, oliguria and occasionally anuria with azotemia. The increase of jaundice noted in some was probably due to the further embarrassment of liver cells occasioned by the inhalation anæsthetic plus the operative manipulation spreading infection. Several of these cases were really resurrected by the judicious use of blood transfusions and the administration of sufficient amounts of saline and glucose solutions. The drainage of bile usually began during the first twenty-four hours, increasing materially the second and third days. The choledochostomy tube was usually free in about ten days for the T or L tube of Kehr<sup>20</sup> was never employed. Bile continued to drain ordinarily until the twenty-first to thirtieth day. In six cases in which the duct was primarily sutured, there was leakage, and thirty days intervened before the biliary drainage ceased. Fifty-eight cases in which the tube was placed in the choledochus were free of bile in twenty-eight days and the fifteen cases in which hepatic drainage was used were dry in twenty-one days. Biliary drainage was regularly non-irritating, and pancreatic ferments were found in the two cases in which a dermatitis of the abdominal wall was present. Inasmuch as carmine crystals given orally did not appear in the wound, it is safe to assume that these were not cases of duodenal but rather pancreatic reflux. The rarity of this complication may be explained by recent anatomical investigations<sup>21</sup> in which it was exceedingly uncommon for the contraction of the muscle fibres in the region of the sphincter of Oddi to convert the common bile duct and the duct of Wirsung into one continuous channel.

Biliary fistulæ as a rule closed in about a month and coincidentally the stools, which were very acholic until then, assumed a dark brown color. Any fistula persisting over eight weeks should make one suspicious of a duct blocked by stone or one accidentally divided at the time of operation. It is still too early to estimate the value of X-ray examination of a biliary sinus injected with lipiodol. In one recent case, not in this series, in which a sinus persisted for more than six weeks, the lipiodol demonstrated quite effectively the biliary tree with the common very much dilated and a blockage in its distal portion just before it entered the duodenum. This was interpreted as due to a stone. Secondary operation revealed a patent duct. The factor of sphincteric spasm was overlooked, and the sinus subsequently closed spontaneously. Four cases which developed a persistent biliary sinus lasting over two months, were reoperated, in two of them calculi had been left behind, and in two the duct had sloughed, necessitating tube reconstructions. Conclusions: The mortality of calculous obstruction of the common and hepatic bile ducts in a series of one hundred and fourteen cases was twenty-three per cent. The figures are not unique for this hospital,<sup>22,23</sup> but represent

the mean obtained in other institutions both here and abroad. This is a sad commentary on medical practice and surgical procedure. As long as the laity in general are induced by the profession at large to procrastinate and temporize and delay surgical intervention until years of transient jaundice and continuous infection have irretrievably devitalized tissue, so long will this mortality be high. And, until surgeons realize that inadequate ante-operative preparation coupled with inhalation anæsthesias and radical one-stage procedures are responsible for their prohibitive death rate in these handicapped patients, the treatment of common duct stone will remain a barrier to the progress of the surgery of the biliary tract.

The author wishes to extend his thanks to Dr. Edwin Beer, Dr. A. A. Berg, Dr. Charles Elsberg, Dr. Howard Lilienthal and Dr. A. V. Moschcowitz, for the privilege of studying these cases on their respective services.

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# STRANGULATED NON-PARASITIC CYST OF THE LIVER

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AND

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THE following case is reported because of the rarity of non-parasitic cysts of the liver and because it presents features not hitherto recorded.

M. P., age twenty-six, was admitted to the U. S. Veterans' Hospital, July 21, 1926, complaining of nausea and vomiting which began the day before. He had some discomfort in the abdomen but no severe pain, although the nausea and vomiting was quite marked.

In the past history there was a diagnosis of pulmonary tuberculosis with two previous hospitalizations. He had noticed a gradually enlarging painless movable tumor in his abdomen for about two years and had been told that its removal would cause death.

On examination a mass was found in the umbilical region extending downward to the brim of the pelvis measuring about 10 x 12 cm. This mass was slightly sensitive. The caecal region was also sensitive but no muscle spasm or rigidity existed. The tumor could be moved laterally in each direction for a distance of 5 to 7 cm. It was smooth in outline and felt quite firm. The temperature, pulse, urinalysis and blood count were normal.

Soon after admission to the hospital the nausea and vomiting ceased and because of this improvement it seemed advisable not to operate at once. Two days later vomiting recurred and the abdominal mass became more tender. He was not, however, considered very ill and operation was postponed until the fifth day of his illness, when it became obvious that exploration was necessary.

*Operation.*—A left rectus incision was made over the tumor. A dark colored mass

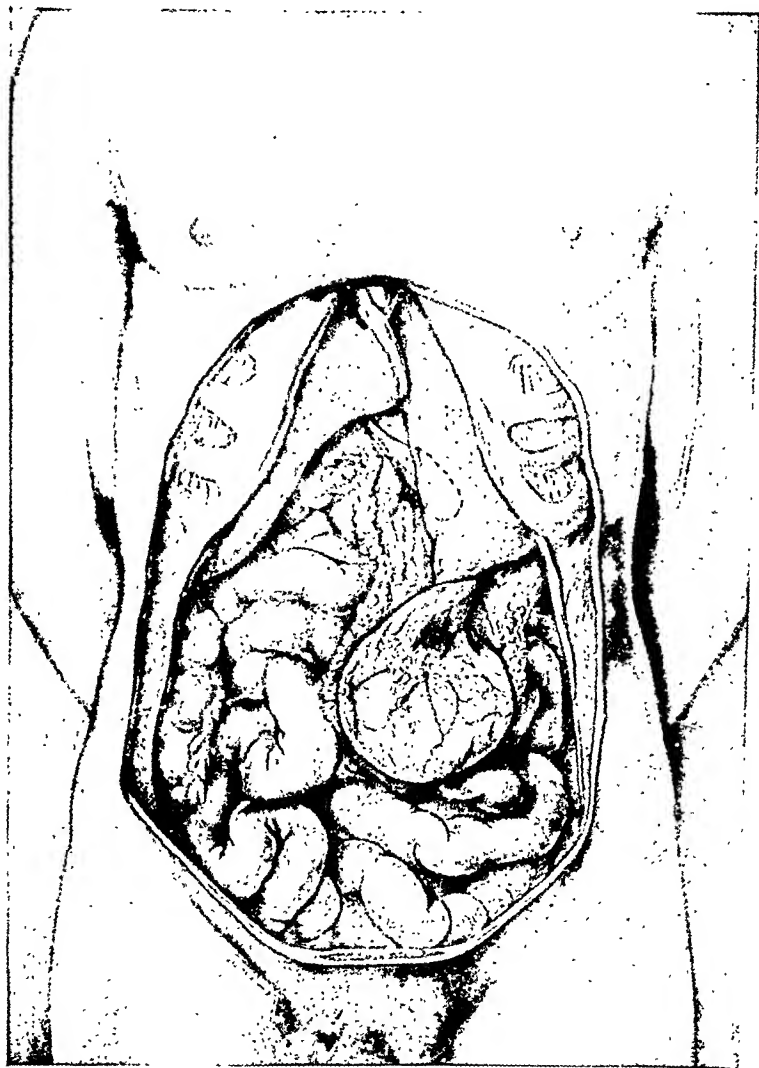


FIG. 1.—Appearance of cyst with its pedicle twisted.

presented with slightly adherent omentum and intestines at the sides. It was found to be attached to the left lobe of the liver by a flat pedicle which was twisted to the right. (Fig. 1.) Beneath the pedicle was found a slightly thickened gall-bladder that was somewhat elongated and drawn downward from its normal position.

The mass was found to be a strangulated cystic tumor which was easily lifted into the wound. With interrupted chromic sutures the flattened pedicle was transfixed and ligated and the cyst removed. The appendix was also removed and the wound closed

without drainage. Recovery was prompt and uneventful.

The tissue was examined by Dr. H. R. Wahl, Professor of Pathology, University of Kansas, who reports as follows:

*Gross Pathology.*—

Specimen consists of a large fluctuating cyst measuring about 15 cm. in diameter. (Fig. 2.) Light can be partly transmitted. There is a rather flattened pedicle 3 by 1 cm. composed of dark red friable tissue apparently of hepatic origin. This pedicle is flattened out over the surface of the cyst and is rather prominent over an area of 4 by 5 cm. On section of cyst, contents consist of a mass of soft light grayish gelatinous material. The wall of the cyst measures 2 to 3 mm. in thickness. Its

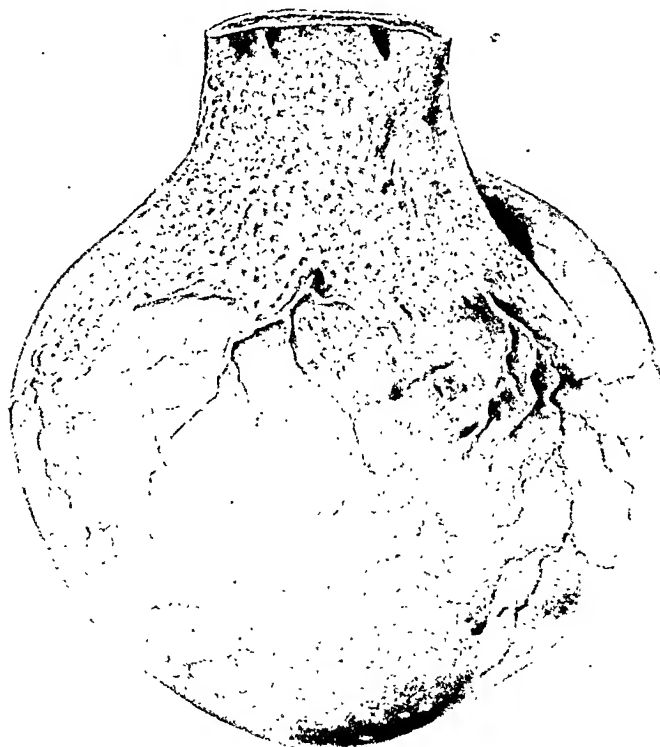


FIG. 2.—Detailed appearance of cyst.

inner surface is fairly smooth with a few ridges and with a few slightly discolored plaques over its lower end. The outer surface is smooth and glistening and shows rather prominent vessels.

*Histological Pathology.*—The section (Fig. 3) shows a laminated wall composed of alternating layers of red blood-cells and fibrous tissue containing many proliferating bile ducts embedded in a rather cellular stroma. The cyst wall itself is lined with a thick wall of fibrous tissue on the inside of which there is a layer of swollen cuboidal epithelial cells which resemble the cells lining the bile ducts. Within this layer there is some hemorrhagic eosin staining material containing a few nests of red blood-cells. Lymphoid cells are scattered about the proliferating bile ducts. There is some liver tissue flattened out over the surface of the cyst showing marked pressure atrophy and consisting, as noted above, of proliferating bile ducts and fibrous tissue. Only here and there are a few nests of liver cells seen showing fatty degeneration. The wall of the cyst in some places shows deposits of calcium corresponding to the discolored plaques noted in the gross.

*Diagnosis.*—Strangulated retention cyst of liver.

In 1923, J. F. X. Jones<sup>1</sup> reviewed the literature and collected 61 cases, including his own, of non-parasitic cysts of the liver that had been subjected to operation. Since then Schraack<sup>2</sup> has reported 6 cases not mentioned

## STRANGULATED NON-PARASITIC CYST OF THE LIVER

by Jones, Maes<sup>3</sup> two cases, Alexander<sup>4</sup> one case, Burns<sup>5</sup> one case, Sims<sup>6</sup> one case, and Metz<sup>7</sup> two cases, making with ours 75 cases which have been operated upon. Jones quotes a letter from Dr. S. W. Harrington<sup>8</sup> of the Mayo Clinic, dated July 18, 1922, in which he states that 25 cases of multiple cysts of the liver had been observed at that Clinic. Only three of these were found when the operation was done for tumor or cyst of the liver. The remaining 22 were discovered at operation for gall-bladder disease, ulcer of the stomach and carcinoma of the stomach.

Jones has collected the opinions of several authors and has decided that non-parasitic cysts of the liver are best classified as: 1. Teratomatous or embryomatous cysts. 2. Pseudo-cysts. 3. Lymphatic cysts. 4. Cystic degeneration of the liver with cystic kidneys. 5. Cysts which arise from blood-vessels. 6. Cystadenoma. 7. Ciliated epithelial cyst. 8. Retention cysts.



FIG. 3.—Microphotograph showing details of cyst wall. 1. Cuboidal epithelium lining cyst. 2. Dense fibrous tissue. 3. Hemorrhage in cyst wall. 4. Proliferating bile ducts.

The determination of the etiology and proper classification in many cases is very difficult. Such cysts are, however, usually quite easily distinguished from the more common echinococcus cyst by the characteristic contents of the latter.

The clinical diagnosis of simple non-parasitic liver cyst is seldom made. If large enough to produce symptoms it is usually mistaken for gall-bladder disease, ovarian cyst, pancreatic cyst, mesenteric cyst or echinococcus cyst. In our case liver cyst was not suspected. We did not even determine that the tumor was cystic but suspected a solid tumor of the mesentery or gut or perhaps a floating spleen.

A retention cyst such as is here recorded is due to the engorgement and dilatation of a bile duct. Just why or how a duct becomes obstructed is not always easy to determine. Calculi and cicatrices have been mentioned as causes. Jones states that it is possible that an unrecognized irritation has caused swelling and hypersecretion in a bile duct, with occlusion of its outlet. Both the pedicle and wall of the cyst in our case showed marked fibrous changes. There was no gross evidence of any general cirrhotic changes in the liver above the pedicle.

The treatment of single non-parasitic cysts of the liver is total removal or marsupialization. In many cases they are so extensive and involve such a large portion of liver structure that removal is too dangerous. Good results have been reported after marsupialization and packing with gauze.

#### CONCLUSION

1. A pedunculated strangulated non-parasitic cyst of the liver is here reported. It is probably the first recorded.
2. Solitary non-parasitic cysts are rare and usually not diagnosed as such.
3. If symptoms are present operation is indicated. Total excision and marsupialization are the operations of choice.

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# THE HEALING PROCESS OF GASTRIC ULCER IN MAN\*

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CLINICAL and pathologic observations have long revealed that certain gastric ulcers heal, but the actual mechanism of the repair and the anatomic factors involved have not been completely analyzed in man. Recent studies of the reparative changes found in experimentally produced peptic ulcers,<sup>21</sup> and in ulcers of the stomach<sup>5</sup> and duodenum<sup>19</sup> in man have demonstrated the usual sequence of events. The present study includes observations of the gastric ulcers resected from thirty patients at the Mayo Clinic. Twenty-three of the patients were on pre-operative regimen before operation because of local or general complications, chiefly obstruction, hemorrhage, gastritis or dehydration. Six patients were studied who had not received medical treatment for ulcer for at least six months before operation. One patient was on strict medical treatment for two weeks before operation was performed.

## LITERATURE

Rokitansky, and later Hauser, believed that the mucosa destroyed in an ulcer of the stomach extending down to the submucosa was repaired, for the most part, by contraction of dense fibrous connective tissue in the base of the ulcer. Hauser and Virchow emphasized the importance of circulatory disturbances (thrombosis, embolism and endarteritis) in the chronic course and in the healing process of peptic ulcer. MacCarty, in 1910, observed epithelium growing from the margin of an ulcer apparently in an attempt to cover the denuded crater. Bolton, in a series of experiments and clinical studies of gastric ulcer, noted that healing in gastric ulcer advanced by several steps: the separation of the necrotic slough in an ulcer base, then the covering of the defect by healthy granulation tissue. The epithelium from the margin of the lesion grew out as a single layer of flat cells which became cuboidal. Glands beginning as a single invagination gradually burrowed into the cellular stroma and formed a new mucous membrane. In the meantime the edges of the ulcer approached one another by contraction of granulation tissue.<sup>1, 17, 33, 34</sup> Askanazy believed with others that in many instances small erosions or acute ulcers heal and disappear as such. Robertson and Hargis from 2000 post-mortem examinations found 141 gastric ulcers, twenty-nine (approximately 21 per cent.) of which were healed.

The cycle of experimentally produced peptic ulcer in animals has been thoroughly studied and described by Mann and his co-workers,<sup>23, 24, 26</sup> from

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the first break of the mucosa with hemorrhage and destruction of epithelium to the covering of the scar-filled defective area. To produce peptic ulcers experimentally Mann substituted a loop of jejunum for the duodenum at the pylorus with drainage of the duodenal contents into the ileum by entero-anastomosis. Promptly after this procedure chronic peptic ulcers developed in the transplanted jejunum. By laparotomy with inspection of the lesions at varying intervals after the primary operation, the approximate time of formation of the ulcer was determined. Frequent inspection and

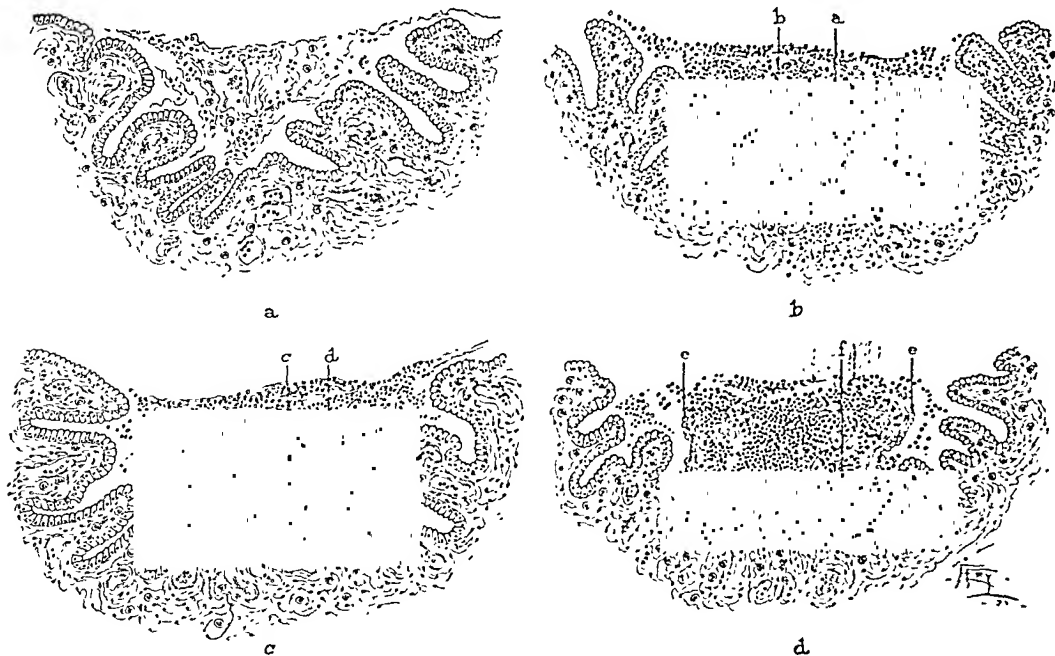


FIG. 1.—The stages of healing of gastric ulcer. a, healed edge of the ulcer; b, (a), break of the mucosa of the base of the ulcer, (b), blood clot in the defect; c, (c), flattened epithelium growing in from the edge of the ulcer, (d), formation of a mushroom of granulation tissue in the defect of the mucosa; d, (d), cuboidal epithelium attempting to cover the plateau of granulation tissue in the ulcer, (f), recent hemorrhage, with a break of the epithelium covering the base of the ulcer.

biopsy of the lesions after gastro-enterostomy illustrated all stages of healing, as well as the time required for complete repair.

To encourage the healing of experimentally produced chronic peptic ulcers Mann occluded the pylorus and drained the stomach by gastrojejunostomy. Anastomosis of the duodenum and jejunum near the site of the ulcer brought about healing in some animals, but the repair was usually slower than with gastrojejunostomy. In the healing of experimentally produced peptic ulcers, when the lesion was completely protected, hemorrhage into the crater of the ulcer rarely occurred. In observations on healing peptic ulcer in man hemorrhage was almost constantly noted, probably because the lesions were unprotected. The extravasation of blood into the cleft of the ulcer was not necessary for healing and at the time of the hemorrhage it probably interfered with the healing process. Granulation tissue grew from the base of the ulcer into the cleft to form a "mushroom" of capillaries and inflammatory cells. Epithelium as a single flat layer grew out from the margin of the lesion up the stalk and over the top of the granulation-tissue mushroom in

the cavity of the ulcer. After the denuded area had become covered and the lesion had healed, the fibrous connective tissue contracted with the formation of deformed and cystic glands so that the final result of healing was a scar-filled excavation covered by atypical epithelium. Mann<sup>24</sup> has found this peculiar granulation tissue plateau or mushroom in experimentally produced peptic ulcers that were healed or partially healed. He found that peptic ulcers of the most chronic perforating type were constantly attempting to heal and that granulation tissue was persistently attempting to form in the cavity of the ulcer. He had also observed a single layer of epithelium trying to bridge a perforating peptic ulcer closed only by omentum.<sup>25</sup> Epithelial cells creep out in this insecure position only to be swept off and destroyed; thus incessant battle between the forces of repair and destruction is carried on.

Morton recently found that excision of bits of mucosa from the stomach following "duodenal drainage operation" after the method described by Mann, was followed by the formation of true chronic ulcer in approximately half of the experiments. The ulcers occurred chiefly along the lesser curvature of the stomach and healing was always delayed.

Wolfer produced experimental ulcers in the stomach by irradiation of the mucosa. The ulcers healed spontaneously in from two hundred to six hundred days.

Kennedy found a duodenal ulcer in a child three days old who had died from melæna neonatorum. The healing changes, observed previously by Mann, were present. I have described similar healing processes in a gastric ulcer removed at operation (Figs. 1, 2, 3, 4, 5, 6); and Crohn and his associates<sup>9, 10</sup> have made similar observations.

The summation of studies on experimentally produced peptic ulcer in animals and gastric ulcer in man establishes the fact that repair occurs in these lesions, with some variations in the sequence and type of pathologic changes. The first prerequisite for healing of gastric ulcer is that the base shall be vascular enough to support granulation tissue,<sup>15</sup> and obviously the larger and deeper the excavation the longer the time required for healing. Early in the formation of the ulcer there is hemorrhage of the mucosa and sometimes of the submucosa and muscularis. There is solution of continuity of the mucosa with necrosis of tissue in the area of the lesion. The necrotic material is replaced by granulation tissue which develops in the base of the ulcer and fills or partly fills the excavation. The epithelium at the edge of the ulcer apparently becomes hypertrophic and hyperplastic. A single layer of flat to cuboidal epithelial cells creeps out on the granulation tissue in the base of the lesion,<sup>23, 24, 26</sup> and when the granulation-tissue bud later contracts the completely healed ulcer is observed as a scar-filled defect covered by irregular folds of epithelium with atypical glands, especially at the margin of the lesion. These glands are lined by cuboidal to columnar cells. Depending on the depth of the excavation the fibrous connective tissue may extend through submucosa, muscularis or down to the serosa. Hauser observed that

the muscle bundles at the edge of an ulcer were pulled up into the base of the lesion and replaced by connective tissue. The scar-filled cavity of the ulcer is not so plentifully supplied with blood-vessels as even the unchanged gastric wall, for the contraction of the granulation tissue markedly interferes with the blood supply.<sup>15</sup> This contraction, together with the atypical epithelium, renders the healed area a point



FIG. 2.—Flattened epithelium covering the granulation tissue in the edge of an ulcer ( $\times 50$ ).

of low resistance, ulceration therefore at the site of the original lesion is not uncommon.<sup>9, 15</sup>

Obviously there are many exceptions to this manner of healing because of the continued activity of traumatic factors. Epithelium at the edge of the lesions may be torn loose from the granulations in the base. In large ulcers the epithelial cells may grow well out on the base of the excavation while the network of blood-vessels in the centre of the lesion is torn loose by traumatic agents and reformed again and again. If the capillaries are torn they bleed and this bleeding retards healing. Blood clot may organize and granulation tissue develop again from the base of the ulcer and epithelium will attempt to cover the plug in the cavity of the ulcer.<sup>8, 23, 24, 26</sup> A lesion may show healing changes in one area and ulcerative destructive changes in another.

#### METHOD OF INVESTIGATION

All ulcers were put in 10 per cent. formalin solution as soon as removed. It is important not to wash the tissue to be examined since exudates, blood and granulation tissue in the cleft of the ulcer might easily be torn off and washed away. Serial sections were made of all the ulcers and they were stained with hæmatoxylin and eosin. The entire diameter and edge of the lesion were included in the preparation unless the excavation was too large for section; there the ulcer was cut in two and preparation for microscopic study made from one portion.



FIG. 3.—Break in the mucosa at (a) with organizing hemorrhage in the defect ( $\times 120$ ).

Pre-operative treatment was advised for twenty-three of the patients in order to combat or relieve complications, especially to overcome dehydration, to reduce gastritis, to allow recovery of muscle tone after gastric retention, to allow a period of recovery from the fatigue of necessary examination, to treat hemorrhage, and relieve retention and vomiting. If a patient

## THE HEALING PROCESS OF GASTRIC ULCER IN MAN

had gastric retention he was kept on a regimen which consisted of two-hour feedings of 200 c.c. of liquid from 6 A.M. to 8 P.M. Liquid food was given since it is quickly and easily assimilated and it can be removed by stomach tube. Fifteen hundred cubic centimetres of 5 per cent. glucose solution was given every twenty-four hours by proctoclysis. The stomach was washed out once or twice daily as seemed necessary and if the patient was dehydrated intravenous injections of glucose and sodium chloride were given. Bleeding from an ulcer was usually managed by rest in bed and transfusions of blood. If retention was not found at examination the hospital care consisted of that usually given in cases of ulcer for a varying number of days. The resected ulcers from six patients who had not previously been treated for ulcer within six months of their pre-operative preparation were also studied. One patient, a physician, with a short history, was maintained under strict medical management for ulcer for two weeks.

### RESULTS

It is fully realized that there are many obvious variations of the sequence of events in the healing of gastric ulcers as outlined, but the steps recorded are those generally found in lesions with healing changes. One of the most common variations in these steps is that the first and second may be interchanged. The action of traumatic agents may cause other differences, as has been mentioned.

In the healing lesions (as determined by the foregoing criteria) the growth of a single layer of epithelial cells from the margin of the ulcer was a stubbornly persistent almost constant factor in repair. This mechanism was present to a greater or less extent in almost every case regardless of the size of the lesion, its duration or the previous treatment. Even if the soft spongy base usually seen in ulcers was replaced by fibrous tissue, the epithelium at the margin attempted to grow out as a single flat layer of cells and covered this denuded area.

The granulation-tissue mushroom which developed in the base of healing peptic ulcers was the keystone of the reparative process. It was found in healed or partially healed experimentally produced peptic ulcers.<sup>24, 25</sup> Kennedy and others<sup>8, 9, 10</sup> have noted its presence. If for any reason this granulation-tissue bud or tuft could not form, or if it formed and could not be maintained in the crater of the ulcer, the lesion remained unhealed indefinitely. I have not found a true ulcer completely healed by epithelial outgrowth from the margin alone. The plateau of granulation tissue must form in the base of the ulcer. Erosions of the mucosa healed as did ulcers. The epithelium grew out on the capillary network which exhibited plateau-like overgrowth. In large ulcers (approximately 1 cm. in diameter and larger) in which a single granulation-tissue mushroom apparently could not form or survive in the crater, many small granulation-tissue buds were sometimes observed scattered in the cavity and particularly in the margin of the ulcer. (Fig. 7.) The smaller tufts had all the characteristics of the larger ones.

They were soft, spongy masses of capillaries and young connective tissue and the epithelium attempted to cover them. (Figs. 8 and 9.) In the whole series no ulcer was found which had healed completely by the formation of granulation-tissue mushrooms either at the margin of the ulcer or in the cavity.

The epithelial cells which cover an ulcer or an erosion are atypical and undifferentiated. At the edge of gastric



FIG. 4.—Flattened epithelium at (a) growing from the edges of the ulcer on the granulation tissue in the base of the defect ( $\times 120$ ).

ulcers Askanazy noted cystic glands, goblet cells and, less often, deformed cells. In some cases he found epithelial desquamation or caruncle. Partially healed gastric ulcers and healed erosions in stomach of man have been studied to determine whether this regenerated epithelium recovered its functional activity. The technic employed was described by Harvey and Bensley and used by them and others<sup>11, 37</sup> in observations on the origin and production of the hydro-

chloric acid of gastric juice. Using indicators, chiefly neutral-red solutions, Harvey and Bensley were able to demonstrate acid reaction in the foveolæ of the gastric glands of experimental animals. The parietal cells were alkaline in reaction and it was concluded that the acid of the gastric juice was not formed in the parietal cells as such, but was probably produced in the foveolæ of the gastric glands and on the surface of the gastric mucosa. I

have employed neutral-red solutions (1:1000, 1:2000, and 1:10,000) applied to small bits of fresh mucous membrane snipped off as described by Dawson and Ivy from partially healed ulcers or erosions. These preparations were observed through a microscope. Razor sections, after the method used by Terry, were also made from healed or partially healed gastric ulcers and erosions and stained



FIG. 5.—Epithelium along the edges of mushroom of granulation tissue at (a) ( $\times 80$ ).

in a like manner with neutral-red solutions. The epithelial cells covering or partly covering an ulcer or erosion stained yellow (alkaline reaction). Occasionally a few cells were noted that stained orange-red (neutral reaction). None of the epithelial cells covering the surface of a partly healed ulcer or erosion stained red. The mucus and the secretion on the surface of the stomach and in the base of the ulcer was the crimson of acid

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reaction. Gastric glands from fresh resected specimens at some distance from the ulcer were studied with the same technic. The parietal cells (which are not plentiful in the pars pylorica <sup>20</sup>) when exposed to neutral-red solutions stained yellow as previously recorded by Harvey and Bensley. Occasionally a parietal cell was found that stained orange-red.

Dawson and Ivy recently repeated a portion of Harvey and Bensley's work, using dogs with Pavlov pouches. They snipped off bits of gastric mucosa from the gastric pouch while the mucosa was actively secreting and within two minutes the mucosa was prepared with neutral-red solution and observed under the microscope. Three distinct types of reaction were found in these preparations. Within the first few minutes the parietal cells, canaliculi of these cells and foveolæ of the gastric glands stained crimson, indicating a hydrogen-ion concentration on the acid side of neutrality. This red color in the cells was quickly displaced, usually within two minutes, by the orange-red of neutral reaction which passed over to the yellow of alkaline reaction. The alkaline tint persisted for as long as twenty minutes when it changed to the red of acid, indicating the death of the cells. The observation of the first acid reaction was essentially the only difference between these results and those obtained by Harvey and Bensley. Dawson and Ivy believed that the first acid reaction was due to the presence of free hydrochloric acid in the parietal cells and foveolæ of the gastric glands and that the second stage of alkaline reaction was probably due to the cessation of acid formation which in turn was due to the excision and to diffusion of acid from the cells. These observers accounted for the difference between their results and those of others by two factors: the material they used was obtained from actively secreting mucosa, and no unphysiologic procedure (such as stunning, bleeding to death, or anæsthesia which are known to inhibit or abolish gastric secretion) preceded excision of tissue for study. In our studies the material was always obtained during operation and the patients were under the influence of a general anæsthetic.

The epithelium covering a partly healed or recently healed gastric ulcer or erosion appeared to be of a regenerative type rather than concerned with secretion. The fact that no acid was demonstrated in the cells by this method was subject to the same criticism as that made by Dawson and Ivy of the work of Harvey and Bensley. Morphologically the epithelial cells covering gastric defects soon after healing were atypical round or oval cells <sup>22</sup> with the nucleus near the centre in contrast to the columnar cells on the surface of the gastric mucosa.

In this series of cases multiple ulcers were frequently found. Judd and Proctor reviewed operations on the stomach performed at the Mayo Clinic in a ten-year period and found that multiple gastric ulcers were present in 6 per cent. of the cases. Since resection of portions of the stomach is becoming more and more common there is every reason to believe that multiple ulcers of the stomach will be found more often. Robertson and Hargis, reviewing post-mortem material, found that in approximately 30 per cent.



of cases of gastric ulcer the ulcers were multiple. In the present series of thirty cases, in fourteen (approximately 46 per cent.) the ulcers were multiple. In a few instances there were ulcers in both the stomach and duodenum.

The entire series of gastric ulcers automatically arrange themselves into three groups: (1) Active unhealed (chiefly the perforating type), (2) recurring, and (3) partly healed. Ulcers designated as perforating were those in which destructive excavation predominated and the chief characteristics were the deep steep-walled ulcer craters. Obviously all ulcers have such characteristics, but in some they are more striking and conspicuous in contrast to lesions in which marginal encroachment of the process seems most prominent. Another ulcer not infrequently noted was of a chronic type and apparently had assumed a perforating form, that is, there was a V-shaped or U-shaped area of necrosis usually in the centre of the crater. This apparently was a recent development in an already established



FIG. 6.—Fresh hemorrhage at (a) with a sharp break in flattened epithelium and loosening of granulation tissue (X 100).

chronic ulcer. In the thirty cases comprising the series studied there were ten ulcers that were classified as perforating. The steep-walled craters were poorly covered by epithelium and usually only necrotic material and fibrous connective tissue were found in the base. Soft spongy granulation tissue was demonstrated only a few times in the cavity of the ulcer. Thrombosis of the arteries and in many cases of the veins was often found in the base of perforating ulcers. Endarteritis was present many times deep in the gastric wall beneath a perforating ulcer. The interference with blood supply which apparently was a feature of these lesions was perhaps a factor in the failure to heal and in the etiology.<sup>40</sup> In some cases of large chronic ulcers which showed a tendency to perforate near the centre, marked arterial changes, chiefly thrombosis or endarteritis, were demonstrated. Obviously healing did not occur near the middle of these ulcers.



FIG. 7.—Isolated tuft or bud of granulation tissue in the base of a large ulcer near the margin of the lesion. Atypical epithelial cells are growing out from the ulcer edge (X 120).

#### TYPES OF HEALING

Two lesions were healed except for slight erosion of the epithelium covering the base of the ulcer. One of the patients, however, had multiple gastric ulcers (three), and two of the lesions were only partly healed. The



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other patient had been on a liquid diet for approximately a year and during this time the symptoms, which had been present for forty years, had been partly relieved.

In seventeen cases epithelium grew from the margin of the ulcer; in seven granulation-tissue buds developed at the rim in the centre of the ulcer, but the lesions were not healed.

In twelve cases epithelium grew from the edge of the ulcer and granulation tissue was present in the base.

In four cases the only healing noted was manifested by epithelium growing from the margin of the ulcer and the organization of hemorrhage of the base.

In five cases evidence of healing was not found. Two of these ulcers were perforating. One patient was a physician who had been on medical management for two weeks without satisfactory results; acids had not been controlled. One patient was a nurse with an acute ulcer without fibrosis in the base. There were many polymorphonuclear leucocytes in abscess-like clumps. She had had multiple recurring gastric ulcers.

In two cases the ulcers were of the perforating type with marked arterial changes.

Although attempts were not made, except in one case, to treat the patients medically, a comparison of the healing changes found in the cases in which pre-operative preparation was given and in those in which it was not given revealed, as would be expected, practically the same state of healing. It is obvious that since the cases studied were not under observation with the idea of treating the lesions medically, but rather to relieve complications (chiefly gastric retention and dehydration) no great difference would be expected in the stages of healing. In experimental ulcers Mann has found that the average time required for healing after gastro-enterostomy or entero-enterostomy was about three weeks.

One of the gastric ulcers which was removed without previous treatment was completely covered by epithelium. Two had mushrooms of granulation tissue at the margin of the crater, epithelium at the edge and granulation tissue in the base. Two had epithelium at the margin and granulation tissue in the base; one had only epithelium growing out at the rim, and one showed no evidence of healing. This last ulcer was of the perforating type.

The size of the lesion was an important factor in healing. The larger and deeper the excavation the longer and more difficult the healing process. In many of the large lesions there were small scattered mushrooms of granulation tissue in the cavity as well as at the margin. (Figs. 7 and 8.) The granulation-tissue buds at the margin of the ulcer appear to be a method of defense of the organism against the marginal enlargement of the lesion. As the usual soft spongy granulation tissue in the base is gradually replaced by fibrosis due to the duration of the lesion and to trauma, the development of the granulation-tissue buds becomes more difficult and their survival more uncertain.

Gram-positive diplococci similar to those described by Rosenow,<sup>35, 36</sup> Gerdine and Helmholz, and others<sup>8, 13, 19</sup> were usually found in the deeper granulation tissue in the base of chronic ulcers and in no other place except on the surface of the adjacent mucosa. *Oidium albicans* was not found in the gastric ulcers in this series. Askanazy and Merke have found

this organism frequently in gastric ulcers at operation and at necropsy.

Fourteen of the thirty cases of gastric ulcer were apparently recurrent; that is, the ulceration was over an area of fibrosis in the wall which extended into the musculature beyond the marginal limits of the denuded area. The epithelium covering the affected areas was atypical as already described, and occasionally the well-known cystic deformed glands were present in the deeper layers of the

mucosa. (Fig. 10.) All but one of the patients gave a history of intermittent distress suggestive of recurring ulceration or formation of a new ulcer.

According to Moore "partially healed gastric lesions give no signs in the röntgenogram that distinguish them from active ulcer. As long as there is any activity in the lesion (unhealed area), particularly in its centre, the Röntgen-ray reveals signs of a lesion."

#### DISCUSSION

In twenty-five of the thirty cases there were healing changes in the gastric lesions of one type or another. The five in which healing was not demonstrated were all of the perforating type and two of these were acute. In one of the two cases in which the lesions exhibited the most advanced healing there were multiple ulcers, one of which was almost completely covered by epithelium; the others were still ulcerated. In the other case the lesion was high on the lesser curvature of the stomach with an hour-glass deformity. The patient lived on liquid food for approximately a year. The lesion was almost completely covered by epithelium but some distress remained.

The intermittent recurrence of symptoms in cases of peptic ulcer may be due to recurring ulceration, partial healing, or formation of a new ulcer. There are not, as far as we know, any definite criteria for judging at what



FIG. 8.—Granulation tissue plug at the margin of a large ulcer with epithelium growing out as a single flat layer (X 40).



FIG. 9.—Higher magnification of the same field as that shown in Fig. 8 revealing the epithelium growing from the ulcer margin as a single row of cells.

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stage of healing symptoms disappear. Data obtained with a gastroscope are inconclusive since the stage of healing cannot be determined. The covering of the denuded area with epithelium does not necessarily indicate that the lesion ceases to cause symptoms. It is probable that the inflammatory reaction deep in the wall with the accompanying changes must subside in whole or in part before symptoms cease. The size of the lesion is an important factor in repair. If lesions are large the reparative processes are so retarded or are so ineffective that they cannot obtain their objective.

Ulcers with overhanging borders which tend to protect the granulation-tissue plug in the base heal apparently much more rapidly than the larger lesions.<sup>8, 10, 19, 33</sup> The poor blood supply in the base of large lesions, the exposure of the reparative elements to traumatic agents, combined with hyperacidity, pylorospasm and the patient's lowered resistance, are a few of the elements that defeat the healing process. Perforating ulcers of the acute type with steep walls and



FIG. 10.—Erosion in the base of a recurring gastric ulcer. Cystic glands are shown in the fibrous connective tissue of the ulcer base.

punched-out appearance, and of the more chronic type (that is, developing in the base of an already established chronic ulcer) showed little or no healing. The marked vascular changes, endarteritis and thrombosis, so frequently found in the base of these lesions, suggest a possible reason for this peculiar behavior. The necrotic material must slough out before healthy granulation tissue becomes available for extensive repair. It seems likely that many ulcers start as small erosions which heal, recur, and break down, and the base enlarges, becomes more fibrotic, heals again and breaks down again. The fibrous tissue in the base continues to become more dense. The lesion with each recurrence enlarges concentrically and penetrates deep into the wall. Finally the ulcer becomes so large and fibrotic and the blood supply is so poor that granulation-tissue buds cannot form, or if formed, cannot persist, and so the keystone of the defensive and healing mechanism is lost. Although I have not seen a large ulcer healed by the formation or multiple buds of granulation-tissue in the base, the marginal encroachment of the lesion has doubtless been retarded by growth of the small granulation-tissue tufts. (Figs. 8 and 9.)

### SUMMARY

Healing changes were apparent in all except five of the thirty gastric ulcers in this series; these five were of the perforating type. The keystone of the healing factors was the granulation-tissue plug first described by Mann in experimentally produced peptic lesions. The size of the ulcer was a significant factor in healing. Large ulcers heal with much more difficulty

than small ones. In the former multiple granulation-tissue plugs may form in the crater or at the margin of the lesions; this latter probably is a defense against the marginal enlargement of the ulcer. Complete healing of a large ulcer by the formation of multiple buds of granulation-tissue was not observed. Epithelium at the margin of the lesions grew out as a single flat layer of cells and covered the granulation-tissue mushroom in the excavation. Later the connective tissue contracted and formed a scar-filled defect covered by atypical epithelium.

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# INGUINAL ENDOMETRIOSIS

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THE recent interest which has been aroused in ectopic endometrial tissue and the relative infrequency of inguinal endometriosis seems to warrant the placing on record of the following case:

Mrs. E. B., aged fifty, was first seen on June 2, 1927. At this time she complained of pain and tenderness in the right inguinal region at about the site of the external inguinal ring. She had been told by a physician, she said, that she had an inguinal hernia. At the external ring was a smooth rounded swelling which was exceedingly tender. Efforts at coughing were painful and no impulse could be felt at the ring. A tentative diagnosis of incarceration of omentum in an inguinal hernia was made and the patient was sent to a hospital. The white blood count was normal and there was no nausea or elevation of temperature. At operation the incision was made over the swelling and cautiously deepened. The empty sac of a small oblique inguinal hernia was entered. At the bottom of the sac, and a part of it, was a firm fibrous swelling some  $5 \times 4 \times 4$  cm. There were no sharp borders or capsules to this swelling which was intimately attached to, and a part of, the rectus sheath. The tissue was carefully dissected out, it being necessary to remove a portion of the rectus sheath. During the removal the dense mass was occasionally cut into and small cyst-like cavities were encountered. These were perhaps 0.5 cm. in diameter and contained a thick chocolate-like fluid. The inguinal hernia was repaired and the wound closed. A hæmatoma developed in the wound some days after the operation. This was evacuated and healed after packing. Otherwise her convalescence was uneventful and she was delighted that her pain was gone. She was discharged from the hospital on July 1, 1927.

The report of the pathologist on the excised tissue was as follows:

"A piece of indurated fibrous tissue and fat,  $9 \times 5.2 \times 2.6$  cm., cut surfaces of which are composed of firm gray-white tissue containing small areas of hemorrhage. In one portion there is a cyst 1.1 cm. in diameter filled with brown semi-solid material and having a slightly nodular lining (Sections).

"There are also two small pieces of indurated connective tissue and fat together equal to 2 c.cm.

"Microscopic: Sections of this tissue disclose fat with dense connective tissue containing small areas of ancient hemorrhage and patches of cellular infiltration with lymphocytes and endothelial leucocytes. There are a few small tubules in this tissue which resemble similar structures seen in the endometrium and these have patches of submucous hemorrhage and masses of granulation tissue attached.

"Diagnosis: Chronic inflammation; transplantation of the endometrium."

Further details of her history were obtained after the operation. She stated she first began to have the pain in the right inguinal region over fifteen years ago and was never entirely free of pain since, although there were variations in its intensity. The pain in the swelling was greater at the time of her menstrual periods and at these times the lump became larger. The menses were painful but regular and lasted five to six days. The hernia was first suspected twelve years ago. The patient had had four normal deliveries, three miscarriages, and no curettages (over a period of seven years). In 1918

she was told that removal of the uterus would help the pain and accordingly in February of that year, a supra-vaginal hysterectomy was done. Since that time, however, the pain has persisted and *was worse at the times when she should have had her menstrual period.*

Inguinal endometriosis has been defined as the presence of endometrial tissue in the groin. The first reported instance was Cullen's case.<sup>1</sup> Here "the growth" was removed and two years later a similar lesion was removed from opposite side. Since that time studies of Sampson<sup>2, 3, 4, 5, 6, 7, 8, 9, 10</sup> have added much to our knowledge of the subject.

Endometrial proliferations have been found on the intestines (rectum, sigmoid, lower mesentery, appendix) and Douglas' peritoneum (rectovaginal septum, posterior wall of uterus, tubes, uterine ligament, ovarian ligament, and bladder),<sup>11</sup> and in laparotomy scars. These proliferations correspond closely to the endometrium histologically and functionally. In 1925, Lemon and Manle<sup>12</sup> reported nine cases in women of ectopic adenomyomata derived from uterine mucosa which had invaded abdominal wall.



FIG. 1.—Photomicrograph of excised tissue. Note tubule lined with epithelium and areas of hemorrhage just outside of tubule.

The origin of these structures is still debated. By some they are regarded as derivatives of a cast-off embryonic portion of the Mullerian duct. Sampson's theory<sup>2</sup> that these proliferations are implantations of endometrium seems to be most reasonable and is supported by the excellent evidence obtained in his studies. Sampson believes that a retrograde menstrual flow which may be either spontaneous or incurred by instrumentation may cause bits of uterine mucosa or tubal epithelium to escape into the peritoneal cavity. These small bits of epithelium may implant themselves on any part of the adjacent peritoneum and there live and proliferate. They may grow upon the ovary and give rise to "chocolate cysts." They may, in any situation, react to menstruation and give off secondary implants. That uterine tissue may be transplanted to other parts of the body and grow has been

demonstrated.<sup>13, 14</sup> Jacobson<sup>15</sup> showed that bits of uterine mucosa scattered into the pelvic cavity of a monkey gave rise to peritoneal implants of this tissue. Sampson<sup>10</sup> calls attention to the fact that occasionally blood is observed escaping from the tubes of patients who are operated upon during their menstrual period, and notes that in 257 cases of peritoneal endometriosis both tubes were patent in 250 cases, one tube open in one, and in the six cases where there was occlusion of both tubes, the peritoneal lesion might have been present before the tubes were closed. It has been suggested that possibly uterine epithelium does not escape from the tubes but that the menstrual blood is capable of causing an endometrial metaplasia of the peritoneum with which it comes in contact.

In 1925, Sampson reported three cases of inguinal endometriosis.<sup>8</sup> In all three of these cases the nodule in the groin reacted to menstruation by becoming more tender at that time. In 1926, Sampson reported a case of "endometriosis of the sac of a right inguinal hernia, associated with a pelvic peritoneal endometriosis and an endometrial cyst of the ovary."<sup>10</sup> This patient, an unmarried woman of forty-four, complained of a right inguinal hernia. In the year previous to operation she was more conscious of her hernia during her menstrual periods. Sampson's pre-operative diagnosis was "right inguinal hernia, probably containing omental tissue." The peritoneum about the right internal abdominal ring was puckered and pigmented. The right round ligament, including the peritoneum about the internal abdominal ring and the entire hernial sac were removed in one piece.

The case reported in this paper is of unusual interest as the inguinal endometriosis might have been explained as a laparotomy implant following the hysterectomy were it not for the patient's unqualified statement that the painful nodule which reacted to menstruation antedated the hysterectomy. The existence of a right oblique inguinal hernia and the presence of the endometriosis at the bottom of the sac lend considerable weight to Sampson's implantation theory. It would seem that an endometrial implant, after being extruded from the tubes, had found its way into the hernial sac and had proliferated at the bottom of it. The hernia had probably never given any symptoms and in fact, was so small that it might possibly be termed a canal of Nuck, a circumstance, however, which does not vitiate the implantation theory in this case.

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# TULAREMIA\*

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THE bacterium tularensis was first isolated by McCoy and Chapin in 1912, in Tulare County, California, where the disease resulting from the inroads of this organism was discovered among ground squirrels.

Tularemia occurs in nature as a fatal bacteriemia in ground squirrels, various species of wild rabbits and other rodents. It is transmitted to man, by the bite of the infected blood-sucking fly, tick, or bedbug, or by contamination of the hands, or conjunctival sac with portions of the internal organs, or body fluids of infected rodents or insects. Many cases occur in different parts of America during the rabbit hunting season, among those who dress or otherwise handle wild rabbits.

The disease has been reported from practically every state in the United States and from Japan. It has appeared in every month of the year, the seasonal incidence being in relationship to the seasonal prevalence of the insects which harbor the organism and also in relationship to the hunting season for rabbits in different localities.

Farmers and their families furnish the largest number of cases, because their occupation exposes them to flies, ticks and wild rabbits. Market men and women, housewives and cooks furnish a second group, and hunters and laboratory workers furnish a large third group.

Approximately 300 cases of tularemia have been reported, and in a study of a series of 220 cases by Francis<sup>1</sup> it was noted that 168 were males, and 52 were females, that the ages ranged from two to seventy-three years. Of this series, eight were negroes.

In most of the attacks occurring in man, the individual has become infected by dressing rabbits, performing necropsies on guinea pigs, rabbits, or white mice, or in handling living rabbits, guinea pigs and living ticks. Cases have been reported following the bite of a hog and of a coyote, and another after the bite of a ground squirrel. It is presumed that the mouth parts of these animals were contaminated by infected rabbits which they had eaten, because dead infected rabbits were found nearby.

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\* "The disease is named Tularemia on account of the presence in the blood of the causative organism *Bacterium Tularensis*. This organism was so named by McCoy and Chapin who discovered it in 1912 as the cause of a fatal epidemic among the ground squirrels of Tulare County, California. Tulare County was so named because that region was once covered with extensive marshy beds of the reed tule, a large variety of bulrush." Francis, Edward, Second Ludvig Hektoen Lecture of the Billings Foundation, from the Proceedings of the Institute of Medicine, Chicago, 1926.

There is one record of transfer of the disease from man to man. This was the case reported by Harris,<sup>2</sup> in which a mother is believed to have contracted tularemia through accidentally pricking her thumb, while changing the dressing of her son who was ill with the disease. No case has been reported of the spread of the infection from man to man by contact, nor by the bite of an insect. Surgeons who have incised or excised suppurating glands have not been known to contract the disease.

In a study of 110 cases Francis<sup>1</sup> found only 27 in which there was an abrasion which apparently was the avenue of infection. He found that the infection will pass through the normal guinea pig skin without abrasion, and without rubbing, but will cause a papule at the site of the infection. Cultures from human blood taken during the first week of illness indicate that there is a bacteriæmia early in the disease. In 77 cases the incubation period was found to be from twenty-four hours to nine days; the average being slightly more than three days.

In 220 cases, four clinical types of the disease were noted. They are: First, ulceroglandular, the primary lesion being a papule; later an ulcer of the skin, and accompanied by enlargement of the regional lymph-glands. Second, oculoglandular, the primary lesion being a conjunctivitis, accompanied by enlargement of the regional lymph-glands. Third, glandular, without primary lesion, but with enlargement of the regional lymph-glands. Fourth, typhoidal, without primary lesion, and without glandular enlargement. Fulminating cases running a rapid course with death, have been noted in the oculoglandular type.

The onset is sudden, and frequently occurs while the patient is at work. It is characterized by fever, headache, vomiting, chilliness, general aching, sweating and prostration. Fever, sweating and prostration persist generally three to four weeks, the fever being intermittent.

In the ulceroglandular type, the patient complains, within forty-eight hours after the onset, of pain in the area of the lymph-glands, which drain the site of the infection. These glandular pains may precede any reference by the patient to the site of infection, which is a swollen, inflamed papule. This breaks down after a few days, liberating a necrotic core or plug, and leaving an ulcer often about three-eighths of an inch (1 cm.) in diameter, with raised edges and having a punched-out appearance. On healing, the ulcer is replaced by scar tissue. The skin is often red over the enlarged and tender lymph-glands, and red streaks may be visible along the lymphatics of the extremity. In about half of the cases, the lymph-glands proceed to suppuration, and if not incised, may rupture through the skin. In other cases, the glands do not break down, but remain hard, palpable, and rather tender for two or three months, gradually returning to normal. Lymph-glands other than the regional glands are usually also affected. Subcutaneous nodules simulating sporotrichosis will usually be present along the course of the lymphatics. These nodules as a rule are distributed over the posterior surface of the forearm and arm, between the ulcer and the enlarged axillary glands.

They are firm and movable, about .5 cm. in diameter and number from 5 to 50 in each case.

The oculoglandular type follows the general description of the ulceroglandular, the primary localization being in the conjunctival sac instead of the skin. Of 15 cases reported, 12 were unilateral, and three were bilateral.



FIG. 1.—Showing lesions of forearm and hand (subcutaneous nodules), some of which have been punctured and pus evacuated. Arrow points to site of initial lesion on index finger.

In the early stage, there is irritation and lacrimation of the eyes, swelling of the lids and surrounding tissues, cedema of the conjunctiva, and usually a papule on the conjunctiva of the lower lid. At the same time there are swelling, tenderness and pain in the surrounding lymph-glands, which in severe cases extends to the cervical and axillary group. Small, discrete ulcers appear very soon on the conjunctiva of both lids. A purulent dacryocystitis has been noted in two cases. No involvement of sinuses has been found. Permanent impairment of vision occurred in one case, which proceeded to blindness following a perforation of the cornea and resulted in fusion of the

cornea and iris into a compact mass. The constitutional reaction is manifest by fever, chills, sweating, prostration, and in severe cases, by convulsions.

In the glandular type the clinical picture is generally that of the ulceroglandular form with the exception that no primary lesion is evident. In the typhoidal type, fever is the outstanding symptom, the onset and duration being similar to that of the glandular type. Diagnosis is confirmed by a positive agglutination test and a negative widal.

Tularemia has been erroneously diagnosed influenza, septic infection, typhoid fever and sporotrichosis. Serologists have considered it undulant fever on account of the cross agglutination of *Melitensis* and *Abortus*.

## TULAREMIA

Pathologists have described the lesions in the lymph-glands as tuberculous. In laboratory workers suffering with the typhoidal type, a history of having worked with, or near animals or insects infected with the disease, is given.

Aside from laboratory workers, patients usually give a history of having dressed wild rabbit, or having been tick bitten, or fly bitten, and about three days later having experienced a sudden attack resembling in many respects an influenzal onset. This

is followed by symptoms of local septicemia. The primary skin lesion first appears in the form of a papule, or there may be primary conjunctivitis. Early, persistent, glandular enlargement occurs in the region draining the primary lesion. Fever is always present at the onset of an initial attack. It is characterized by rise and remission lasting for several days, after which there is gradual decline to normal, lasting from one to three weeks. The diagnosis is confirmed by agglutination of the bacterium by the patient's blood serum. The blood is collected and forwarded as for a Wassermann test.<sup>†</sup> This test



FIG. 2.—Enlarged cervical gland at fourth week.

becomes positive during the second week of illness. Microscopic or cover glass preparations and cultures taken direct from the patient are considered useless. Guinea pig, or rabbit inoculations are best to determine the presence of the organisms.

CASE REPORT.—W. E. S., a white man, aged thirty-two, American, married, on November 18, 1926, dressed several wild rabbits which he had shot in central Ohio. Forty-eight hours later he experienced chilly sensations while at work in his office, and later had a distinct rigor, followed soon by a temperature of 104.5 degrees. He was under the impression that he might be suffering from influenza. He had noticed

<sup>†</sup> In the absence of a convenient laboratory equipped for the diagnosis of tularemia by agglutination, blood specimens are best forwarded direct to the Hygienic Laboratory, Washington, D. C.

some discomfort in the right epitrochlear and axillary regions, and a small lesion upon the index finger.

Physical examination after the chill revealed a single round lesion on the flexor surface of the right index finger just over the distal joint. It was about .5 cm. in diameter and appeared as a dried bleb with a peculiar darkened centre and markedly red border.

Red lines along the course of the superficial lymphatics of the forearm were apparent, and the epitrochlear and axillary lymph-nodes seemed moderately swollen.

Soon after the onset there was a peculiar, painful, involuntary twitching of the muscles of the right side of the face. After about thirty-six hours this symptom disappeared.

For two days after the onset, his temperature ranged from 103.5 degrees in the evenings, down to 100 in the mornings, and gradually subsided to about 101 in the evenings. About the tenth day the temperature again rose to 102 in the evenings. The pulse rate remained low or near normal; the volume rather full, somewhat similar generally to the pulse of typhoid fever. There was a slight intermittent epistaxis at first for two or three days. The

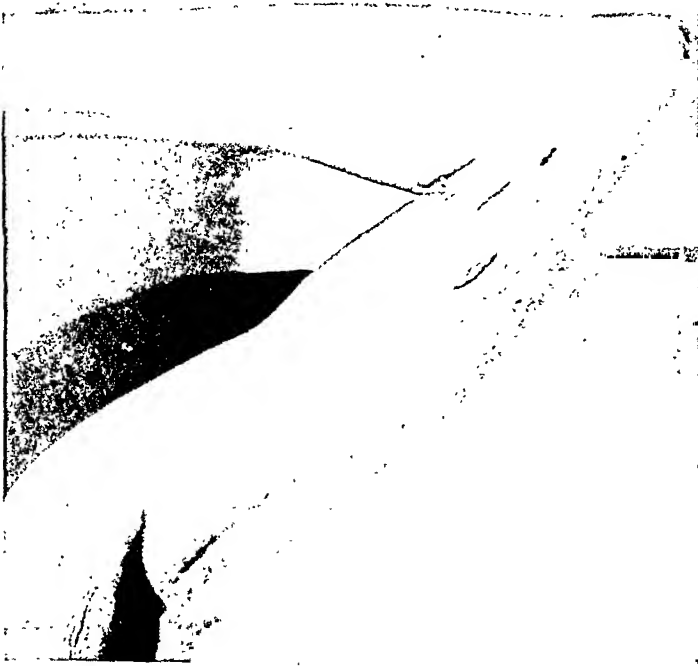


FIG. 3.—Incisions at site of epitrochlear and axillary abscesses.

chest and abdomen were negative. Nausea or vomiting did not occur. The leucocyte count at this time was 22,500. The blood Wassermann was negative. The urine showed a trace of albumen.

On the fifteenth day the epitrochlear glands seemed to fluctuate. He was admitted to the hospital and the epitrochlear region freely incised, evacuating about 10 c.c. of yellowish, odorless pus. The initial lesion on the index finger was excised. It had become an undermining ulcer with a small necrotic centre, and had shown no tendency to heal.

During the second week there appeared about two dozen other small lesions upon the effected hand and forearm. These developed as subcutaneous nodules along the course of the superficial lymphatic channels on the extensor surface of the hand and forearm. They were about .5 cm. or less in diameter, round, elevated and on palpation felt markedly indurated as though each might contain a bird shot. Nearly all were incised and a drop of thickened pus evacuated. There was one enlarged submaxillary gland on the right side, about 1.5 cm. in diameter.

The patient left the hospital on the twenty-eighth day with temperature normal except a fraction of a degree of fever in the evenings. On the thirty-fourth day there was again fever of 101 degrees. Two more infected epitrochlear glands which had appeared, were opened at this time, and free pus evacuated.

On the forty-first day, fluctuation appeared in the enlarged axillary glands. They were incised and about 15 c.c. of pus evacuated. Discharge never persisted after evacuation of affected areas, and on each occasion after incision, there was distinct improve-



# THE CLINICAL MANIFESTATIONS OF NON-METALLIC PERFORATING INTESTINAL FOREIGN BODIES

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THE occasions on which foreign bodies, such as chicken or fish bones are accidentally swallowed with the food, must be very numerous. Usually unless they lodge in the pharynx or oesophagus, they give rise to no immediate symptoms or alarm, and doubtlessly in the great number of instances, are passed without further incident. In certain cases, however, the relative frequency of which it is obviously impossible to determine, their further progress becomes arrested at some point in the intestinal tract. Then, as a result of their physical characteristics which conduce to penetration and perforation, they may give rise to clinical manifestations which are extremely puzzling.

A word of explanation is perhaps in order to account for the limitation of this communication to the consideration of only *non-metallic* foreign bodies. Metallic foreign bodies are excluded because they present a different clinical problem. The ingestion of one of these objects, such as a pin, needle, etc., is a more or less dramatic and alarming event, which brings the patient under observation at once, or at least impresses itself vividly upon his memory. The problem then resolves itself into the observation and treatment of a potentially perforating foreign body, known to be present in the gastro-enteric tract. Furthermore the ease with which they are demonstrated by the X-ray, gives definite knowledge of their presence, and facilitates the subsequent study of their course. With the non-metallic type of foreign body, under discussion, however, the patient presents himself as a rule only after perforation has occurred. And, as will be seen, with marked variations in the clinical picture. By this time, he has forgotten, if he ever noted, the swallowing of a chicken or fish bone, and he certainly never thinks of connecting the present serious plight, with so minor an occurrence. The X-ray of these cases is of practically no assistance.

In the twelve cases, which are here reported, fish bones were found six times, fragments of chicken bone five times, and a sliver of wood (tooth-pick) once. However, any relatively short, sharp-pointed non-metallic foreign body, would fall into this category. In the literature, cases due to bristle, bits of stubble, a piece of cherry stem, etc., have been reported. Fish bones, however, are by far the most frequent.

The cæcum and flexures of the colon are the most frequent sites of perforation. Arrest of one of these foreign bodies in the normal small intestine, is uncommon. On the other hand, conditions such as prevail in a large hernial sac, tend to favor the lodging of a sharp-pointed object at that point.





TYPE I.—*Cases with Symptoms of Peritonitis.*—These are relatively uncommon, and are caused by foreign bodies which become impacted when lying transversely to the long axis of the bowel. Chicken bones are apparently the most frequent cause, and the lower ileum, the narrowest portion of the small intestine, the most common site of this type of perforation. Three different mechanisms are possible.

(a) The foreign body produces an area of necrosis, and gradually works its way through. In this type there are apt to be two areas of necrosis, namely one at each end of the foreign body. (Case I.)

(b) An area of necrosis results. The foreign body may pass on, but secondary perforation occurs due to a sloughing of the compromised area.

(c) A foreign body of small diameter, and very sharp and rigid, may be pushed through the intestinal wall, with the production of a minimum amount of necrosis. In this type of case there may be perforation into an adjacent viscus.

The onset of symptoms in these cases is fairly sudden. The violent pain and shock ordinarily associated with perforation of a hollow viscus is absent. This is probably due to the fact that as these perforations occur rather slowly, a certain degree of peritoneal reaction ensues, before actual perforation takes place. Furthermore, the foreign body may act as a plug, thus preventing the escape of large quantities of intestinal contents. The usual signs and symptoms of peritonitis are present, but are too indefinite to give any clue as to its point of origin. The diagnosis of appendicitis is usually made. Upon laparotomy a sero-purulent exudate is found, there being no evidence of gross intestinal soiling. The usual foci are found to be normal, and further exploration reveals the presence of a foreign body. Its location is facilitated by the fact that there is a certain degree of dilatation above and constriction below it.

CASE I.—S. B., age fifty-three, was admitted to the Mt. Sinai Hospital, November 7, 1924, with a history of having had recurrent generalized abdominal colic at intervals, for the past few weeks. Three days ago, the pain became much more severe, and tended to localize in the right lower quadrant. On the day before admission, he had had a chill, was nauseated, and vomited. His temperature was 101° F. Examination of the abdomen revealed moderate distention with direct and rebound tenderness equal in both lower quadrants. No masses palpable. Rectal examination negative. A tentative diagnosis of appendicitis with peritonitis was made. At operation, the abdomen was opened through a right rectus incision. A considerable quantity of sero-sanguinous fluid escaped. The intestines were covered with scattered areas of fibrin. Exploration of the appendix, gall-bladder and colon, revealed no abnormalities. On further examination, a greatly dilated and congested loop of ileum was encountered. Immediately below it the gut was slightly collapsed. Closer inspection revealed an area of necrosis, about 2 cm. in diameter, with a small perforation at its centre. This was due to a chicken bone, 2 inches in length, lying transversely in the bowel. There was no perforation on the opposite side of impingement. The chicken bone was removed, and the necrotic area, together with the perforation, inverted by two rows of Lembert sutures. Because of the friable nature of the intestine, and its narrowing by the inverted sutures, a short-circuiting entero-anastomosis was deemed advisable. After a rather stormy convalescence, patient made a complete recovery.



at the base of the right lung. The upper abdomen was rigid throughout. Tenderness, both direct and rebound, was most marked in the right upper quadrant. The white count was 8500 with 80 per cent. polymorphonuclears. The case was considered to be either a peri-cholecystic abscess or a slowly perforating duodenal ulcer, which was being walled off. Under observation the upper abdominal rigidity and tenderness localized definitely to the right upper quadrant. The white blood count rose gradually to 19,000, and finally a distinct mass could be palpated in the right upper abdomen. A diagnosis of pericholecystic abscess was made, and the abdomen opened through an upper right rectus incision. An abscess cavity containing large quantities of foul-smelling pus was entered. As the pus escaped, a fishbone, about one inch in length, was detected. The abscess cavity was sponged dry, and a small sinus was found leading downward and to the right toward the hepatic flexure. A tube was passed down to the sinus, and the abdomen closed in layers. There was profuse drainage and fascial necrosis occurred. The wound was opened down to the fascia, and allowed to heal by granulation. There was complete healing within a few weeks, without fecal discharge occurring at any time. It was interesting to note that bacterial culture of the pus showed no evidence of colon bacilli, only an anhaemolytic streptococcus being found. Unfortunately, no direct smears or anaërobic studies were made, but it is probable that anaërobic intestinal organisms were present in addition to the streptococcus, and accounted for the foul odor of the pus.

CASE IV.—J. D., age forty, was admitted to the Mt. Sinai Hospital, August 18, 1920. Five days before admission, the patient noted marked abdominal distention upon awakening. Shortly afterward he vomited. Two days later there followed pain in the right lower quadrant, which has persisted to date. Temperature was 101° F. Abdominal examination revealed a slightly tender mass about the size of a small orange, in the right lower quadrant. Rectal examination was negative. A pre-operative diagnosis of appendicitis with abscess was made, and the abdomen opened through a four-inch Kammerer incision. The appendix was delivered, and found to be normal. On further examination, a retrocolic mass was palpated. The peritoneum alongside the colon was incised, and the latter mobilized. A small retrocolic abscess was discovered, and evacuated. In the posterior wall of the upper part of the cæcum, a fragment of toothpick, about one inch in length, was discovered, lying apparently completely outside of the lumen. Near this the cæcal wall was necrotic for an area about 1 cm. in diameter. The toothpick was removed, and the necrotic area sutured over. The retrocæcal region was drained with a rubber tube, and the patient made an uneventful recovery. The interesting point about this case is that the abscess was really retroperitoneal, and if operation had been delayed, might have pointed as a lumbar abscess.

CASE V.—E. B., age twenty-seven, was admitted to Mt. Sinai Hospital, October 20, 1917, with a history of pain in the left hypochondrium of two months' duration. He had had three such attacks, each one lasting about five days. The present attack had begun four or five days before admission. The temperature was 102° F. Examination revealed a tender mass in the left upper quadrant of the abdomen, apparently an intra-abdominal abscess. White blood count was 17,000 with 77 per cent. polymorphonuclear. At operation, the abdomen was opened through a left upper rectus muscle splitting incision. The posterior rectus sheath and peritoneum were thickened and œdematous. Adherent to the peritoneum was a walled-off abscess. This was opened, and a large quantity of foul pus escaped in the course of which a fish bone was found. The abscess cavity was drained with a rubber tube, and the perineal wound closed. The parietal wound was partly closed, and the portion around the tube packed lightly with gauze. There was a rapid, uneventful recovery.

CASE VI.—R. B., age forty-seven, was admitted to the Mt. Sinai Hospital, with a history of severe pain in the left upper quadrant of a few weeks' duration. He had no other gastro-intestinal or any other symptoms. On admission, his temperature was 100.2° F. Physical examination disclosed a moderately tender mass in the left upper

quadrant. A perforating neoplasm of the colon was suspected, but a barium enema showed no abnormalities. Operation: The patient was explored through a six-inch upper left rectus incision. Beneath the rectus muscle, a small sinus was encountered, which led down to an abscess cavity encapsulated between a mass of omentum, and the anterior abdominal wall. The abscess was evacuated, and exploration of the omentum disclosed a small intra-omental abscess in which lay a fishbone. The omentum was seen to lie just anterior to the distal extremity of the transverse colon. Drainage: With a rubber tube, and closure of the abdomen in layers. The patient made an uneventful recovery.

· TYPE III.—*Cases Presenting Themselves as Intra-abdominal Tumors.*—A few cases have been reported in the literature where the perforated foreign body was found after a portion of the colon had been resected; for what was apparently considered a malignant tumor. In a few other cases of resection for inflammatory peri-colonic tumors, where no foreign body was found, the descriptions of the operative findings are such, that one is led to suspect that a foreign body had been present, and perhaps later passed per vias naturalis, or migrated as in one of our cases. The three cases recorded below, all of whom were private patients of Dr. A. A. Berg, are to our belief the only ones reported in the literature in which the cause of the inflammatory peri-colonic tumor was suspected and the offending foreign bodies sought and found at operation. One of us (L. G.) was present at the operation in two of these cases, and Doctor Berg has been kind enough to furnish a description of the operative findings in the third.

This group is an extremely important one because of the mistakes that may be made in diagnosis, prognosis, and operative indications. The site of perforation is usually the colon, and takes place so slowly that acute symptoms are frequently lacking. A low grade infection results, in which the inflammatory reaction is mainly productive. In addition, there is a typical tissue reaction to the presence of a foreign body, such as described above. As a result, inflammatory peri-colonic masses of considerable size may be formed. In some cases the omentum becomes adherent, and secondarily involved with the formation of an inflammatory omental tumor. The foreign body may pass into the omentum, so that a mass of inflammatory granulation tissue remains around the colon, the etiology of which is in doubt even during the operation, because of the migration of the original causative factor. It must be emphasized that this type of inflammatory tumor is completely extra-colonic. They are not to be confused pathologically with other inflammatory granulomata of the bowel, such as reviewed by Tietze,<sup>4</sup> in Germany, and recently by Wilensky<sup>5</sup> and Moschcowitz in this country. In these, the mucosa and submucosa are the seat of ulcerative and chronic and subacute inflammatory changes. In the inflammatory tumors, which result from perforated foreign bodies, the mucous membrane, and the walls of the intestine, are not the seat of any marked changes, except perhaps for a small sinus, leading to the mass, lined perhaps with giant cells. At times, a slight scar is all that will mark the site of penetration.

The history in these cases is that of gradually increasing local pain and

tenderness, with the development of a large hard mass, which is frequently first noted by the patient himself. As there is no involvement of the gut proper, there are as a rule, no signs of obstruction or colitis. The severe colicky abdominal pain, characteristic of colonic neoplasm, is usually absent. Vomiting, diarrhoea and melena are infrequent. The disparity between the size of the mass, and the absence of impairment of nutrition, or anæmia, is striking. Röntgenologically there is no filling defect.

At operation, as pre-operatively, the main difficulty is to be sure that one is not dealing with carcinoma of the colon, for in the latter case a radical, and in the former, a conservative procedure is indicated. Differentiation from peri-diverticulitis may come up, but is of lesser importance. Some information may be gained from the inflammatory thickening of the posterior rectus sheath, and peritoneum, due to the long-standing infection, which is more common here than a carcinoma of the colon. These tumors are firm, but smooth, and do not encroach upon the intestinal lumen. Malignant tumors of the colon, on the other hand, are nodular, irregular, and can be felt to cause either stricture or irregular projections into the lumen of the gut. Small abscesses may at times be found in the inflammatory tumors, which should be carefully inspected after evacuation, as they may lead to the foreign body. The major portion of the inflammatory tumor may at times be formed chiefly by a mass of inflamed omentum.

CASE VII.—A. K., was admitted to the Mount Sinai Hospital, July 20, 1926, with a complaint of pain in the left upper quadrant of the abdomen of eight weeks' duration. Pain was localized, and did not radiate. It was more or less constant, and had no definite relation to the intake of food. For the last three weeks, the bowels have moved only with the aid of cathartics. The patient also stated that the stools had become smaller in diameter. There was no melena, vomiting or diarrhoea, nor were there any urinary symptoms. He had lost 20 pounds in weight since the onset of his illness. However, he appeared to be fairly well nourished, and his hæmoglobin was 95 per cent. In the left upper quadrant of the abdomen, and in the left flank, a large, slightly tender mass, was palpable. In order to rule out the possibility of the mass being renal in origin, an X-ray of the urinary tract was taken. This showed the kidney to be normal in size and in position. X-ray of the colon showed no filling defect. A pre-operative diagnosis of inflammatory tumor, or carcinoma of the splenic flexure, was made. At operation, a large mass was found occupying the splenic flexure, and upper portion of the descending colon. This was carefully separated into two component parts, one of which consisted of thickened, inflamed omentum, the other was a large, smooth, firm, peri-colonic mass. There was no evidence of any invasion of the colonic lumen. In the midst of this mass there was seen to be a depressed area, of what was apparently a healed fistulous communication with the gut. The omental mass was then further explored, and two fish bones were found lying in separate small abscess cavities. The abdomen was closed with rubber tube drainage, and the patient made an uneventful recovery.

CASE VIII.—Mrs. H., was admitted to Mt. Sinai Hospital, January 7, 1924. She had been previously operated on for chronic cholecystitis and cholelithiasis, and a cholecystectomy was performed. Following this, she was well for a few months, until a few weeks before admission, when she again developed severe pain in the right hypochondrium. This pain was continuous, and did not radiate. There was no jaundice. Concomitantly, the patient noticed the development of a tender mass in the right upper

quadrant. She gave a history of having had attacks of chills and fever, but during her stay at the hospital, her temperature remained normal. In the right upper quadrant of the abdomen, a large, hard, tender mass was palpable behind the old scar. The mass was only slightly tender. A pre-operative diagnosis of abscess, around the stump of the cystic duct was made. At operation, the incision was carried down through the old gall-bladder scar, which was excised. The posterior rectus sheath and peritoneum were greatly indurated, and cedematous, but showed no infiltration. A large mass was found occupying the region of the hepatic flexure of the colon. It was at first thought to be carcinoma, and the hepatic flexure was mobilized in order to permit of better inspection. The mass was found to be hard, but not nodular, and was apparently completely pericolic, there being no invasion of the intestinal lumen. It was concluded that the mass was inflammatory in nature, and on further exploration, a fish bone, 2 to 3 cm. long, was discovered lying in inflammatory tissue. There was no evidence of the site of perforation, which had apparently healed over. There were a few drops of pus in various portions of this inflammatory tumor. The abdomen was closed with rubber tube drain, and an uneventful recovery ensued.

CASE IX.—Mrs. R. V., was submitted to Mt. Sinai Hospital, June 29, 1926. She had been completely studied on the outside, and was sent for operation with a diagnosis of carcinoma of the colon. Unfortunately, the pre-operative findings are not at our disposal. On examination, a large, hard mass, slightly tender, was palpable in the right upper quadrant. Operation was undertaken for a suspected tumor of the hepatic flexure. As the peritoneum was opened, a small abscess was encountered, encapsulated between the anterior parietal peritoneum, and a large mass in the region of the hepatic flexure of the colon. The tumor gave the impression of being inflammatory in nature, and after a careful dissection a chicken-bone, about one-eighth of an inch in diameter, and two inches in length, was encountered, just protruding through the mass. Drainage with a rubber tube. After prolonged and profuse discharge of pus, patient was discharged from the hospital completely well.

TYPE IV.—*Cases Presenting Themselves as Tumors of the Abdominal Wall.*—These apparently develop a considerable time after the perforation of a foreign body. The symptoms following the original extrusion may be so mild as to occasion only slight disability, or as in our case to completely escape notice. The tumors are hard, fixed, and well demarcated. There may be no signs of inflammation. Desmoid of the abdominal wall, sarcoma, actinomycosis, and in smaller tumors, metastatic carcinoma, are usually considered in a differential diagnosis. The following should make one suspicious of an apparent abdominal wall tumor being due to a perforating foreign body.

(1) Its proximity to the umbilicus. (2) Its situation deep to the rectus muscle, to which it is frequently very adherent. (3) If on biopsy small collections of pus are encountered. In cases of doubt, of course, biopsy with microscopic examination should be performed.

CASE X.—J. C., age sixty-five, was admitted to Mount Sinai Hospital, April 30, 1925. For the past few months the patient had noted the development of a mass above and to the right of the umbilicus. There had been no pain associated with its development. It had never been reducible. Physical examination showed a hard, smooth, spherical mass, about three inches in diameter, to the right and above the umbilicus. It was not tender, and there were no signs of inflammation. There was no cough impulse. The pre-operative diagnosis was that of a tumor of the abdominal wall, or an umbilical hernia, with irreducible, thickened omentum. An elliptical incision was made around the mass, and the tissues found to be normal down to the rectus muscle. The posterior

aspect of the rectus muscle, the posterior rectus sheath and peritoneum were involved in a mass of dense, grayish tissue. To effect its removal, the abdominal cavity had to be entered. The omentum was then found to be adherent to the mass, but was not apparently involved in the inflammatory process. There were no evidences of any adhesions of any of the abdominal viscera to the deep surface of the tumor. The tumor, when excised, was still considered to be a neoplasm, and the specimen was cut across for further inspection. In the depths of the mass a small collection of pus was found, and in its centre was a fish bone 2 to 3 cm. long. Culture showed staphylococcus albus, and an anhaemolytic streptococcus. The pathological description follows: "The macroscopic specimen consists of tumor mass, to which is attached a resected portion of omentum, and some adherent muscle. The tumor mass measures about 7 to 8 cm. in diameter, is oval in shape, firm in consistency, and on section presents a small sinus tract containing a foreign body about 3 cm. long. (Fish bone.) Microscopic examination discloses a fibroma showing numerous inflammatory areas. A few multinuclear giant cells are present in the tissue adjacent to the foreign body."

A practically similar case was found accidentally in the course of a general physical examination, is reported by Morian.<sup>6</sup> Stetten<sup>7</sup> recently presented a case before the New York Surgical Society, in which a small tumor in the region of the umbilicus, was removed under the suspicion that it might be a metastatic carcinomatous nodule. Upon excision, the tumor was found to consist of a central core, composed of a fish bone surrounded by thick, inspissated pus. Wölfler and Lieblein quote a case, where the suspicion of abdominal wall sarcoma existed. Biopsy was performed, and revealed a chronic inflammatory tissue. The mass was then thought to be actinomycosis. About six weeks later, there was a sudden discharge of pus, in which a cherry stem was found.

*TYPE V.—Cases Presenting Themselves as Abdominal Wall Abscesses.*—These result when the involved gut becomes adherent to the parietal peritoneum, before perforation occurs. The site of perforation closes very rapidly as a rule, so that an abscess containing intestinal bacteria may be found without any evident communication with the gut. If the foreign body is not discovered, when the abscess is opened, a chronically discharging sinus will, of course, develop.

*CASE XI.*—T. H., age sixty-six, was admitted to Mount Sinai Hospital, in January, 1924, with a large red, painful swelling, occupying the antero-lateral aspect of the lower portion of the left chest, and extending down to the left upper quadrant. It had first appeared five weeks ago, and increased rapidly, in size since then. She had lost twenty pounds in weight, and felt weak, but there were no gastro-intestinal respiratory, or urinary symptoms.

Aspiration of the mass revealed pus from which Gram-negative bacilli (colon), and Gram-positive cocci and bacilli, were isolated. A perforating neoplasm of the splenic flexure was suspected, but a barium enema showed no abnormality of the colon. The abscess was laid wide open, and explored, but no communication with the gut could be found. Six months later she was re-admitted to the hospital with a sinus running downward and inward from its external opening at the ninth rib in the anterior axillary line. Injection of dyestuffs, and Röntgen examination, after the injection of opaque substances, failed to show any communication with the gastro-intestinal or genito-urinary tracts, or chest. There was no evidence of osteomyelitis of the ribs. Operation was proposed, but refused.

Four months later, she was again re-admitted with an abscess in the original situation. It was split open by an oblique incision, running from the ninth rib in the anterior axillary line, downward and inward to the left upper quadrant of the abdomen. At the abdominal extremity of the abscess cavity, a spicule of bone, about 2½ cm. long



## NON-METALLIC PERFORATING INTESTINAL FOREIGN BODIES

and  $\frac{1}{2}$  cm. in diameter was found. It looked like a bit of chicken bone. The wound was packed and rapid healing followed. The pathological report reads: "The bone sliver has probably been present in the abscess cavity some length of time, as all the collagen substance has been digested, and only mineral substance remain."

**TYPE VI.—*Inflammation and Obstruction in a Hernial Sac.***—Large irreducible hernias of all types are favorite sites for foreign body perforation. The kinks, angulations, and adhesions of the gut all favor the arrest of a foreign body. Judging from the statistics of Wölfler and Lieblein, these occurrences were much more common years ago, when early operation for hernia was less frequent, and large irreducible hernias more common than nowadays.

Both of the cases in our series occurred in large, irreducible umbilical hernias, one of which was a recurrent one. The clinical picture will vary, depending upon whether there is perforation with escape of the foreign body into the sac, or whether there is impaction in the lumen of the gut coincident with the perforation. In the former, the signs will be mainly those of local inflammation. See Case I. In the latter, there will be inflammation, plus signs of ileus. It is interesting to note that in both of the cases reported below, where the large ventral hernias were practically subcutaneous, the signs of phlegmon of the abdominal wall were so marked that there was considerable discussion before operation as to whether a hernia was actually present.

At operation, when the sac is opened, an abscess is usually encountered. When the signs of obstruction have been marked, simple drainage of the abscess is not sufficient. The loops of gut adjacent should be carefully palpated, and enterotomy performed if necessary to remove the foreign body. Close of the enterotomy may sometimes be impossible due to the friability of the intestine. In such cases, it may be advisable to use the opening for an enterotomy. Of course there should be no attempt at reduction or repair. Any manipulation, which might break down adhesions, separating the local process from the general peritoneal cavity, should be sedulously avoided.

**CASE XII.**—Mrs. A. H., age fifty-eight, was admitted to the Mt. Sinai Hospital, in May, 1923. She had had an umbilical hernia repaired four years ago. Her present illness began three days before admission with pain, redness and swelling around the centre of the abdomen. She had experienced chilly feelings, and her temperature had been elevated. There was no history of abdominal pain, vomiting or constipation. On admission, her temperature was  $103^{\circ}$  F. In the centre of the abdomen, there was a large, red, hot, tender, indurated area, about six inches in diameter, over which fluctuation could be detected. It was impossible to tell whether or not the hernia had recurred. A small vertical incision was made over the maximum point of fluctuation. A localized fecal abscess was encountered, and evacuated. The posterior wall of the abscess was formed by small intestines densely matted together. Two pieces of chicken bone, about one inch in length and one-quarter inch in diameter, were found lying free. The sites of perforation could not be discovered. Following drainage and subsidence of the acute inflammation of the abdominal wall, it was found that the patient had a large recurrent umbilical hernia. The wound healed rapidly, without any fecal discharge.

**CASE XIII.**—Mrs. H. W., age sixty-two, was admitted to Mt. Sinai Hospital, December 16, 1926. Her chief complaint was abdominal pain and vomiting, three days'

duration. She had always had a large pendulous abdomen. Four days before admission, she noticed that it was beginning to get hard in the centre, in contra-distinction to its usual flabby character. That night she experienced mild cramp-like, generalized abdominal pain. For the past two days she had vomited frequently. Examination revealed an obese, very acutely ill woman, with a rapid pulse, and in poor general condition, who was vomiting intestinal contents. The abdomen was large, pendulous, and greatly distended. The region around the umbilicus over an area of four inches in diameter was acutely inflamed and indurated. It could not be definitely determined whether a hernia was present. However, the case was thought to be a local strangulation within one of the lobules of the sac with peritonitis, or a perforating intestinal foreign body. A four-inch incision was made, extending above and below the umbilicus. Pus was encountered just beneath the skin. The incision was enlarged, and the pus was found to come from the sac of an umbilical hernia. There was no evidence of any strangulated intestine. Because of the marked obstructive symptoms, it was thought advisable to perform an enterostomy. In passing the tube, an obstruction was encountered about one and one-half inches from the opening of the intestine. This was investigated, and found to be a chicken bone. The bone was removed, enterostomy performed, and the abscess cavity drained. That night the patient suddenly died. Autopsy showed the cause of death to be due to coronary artery disease and nephritis. The loop of gut in her hernia, which had perforated, was terminal ileum. Apparently there had been two chicken bones, only one of which had been removed at operation. The other was *in situ* but not perforating. There was a dense coat of fibrin around the original perforation, which opened into an irregular sacculated cavity, containing fecal matter. The posterior wall of this cavity was formed by a mass of adherent small intestine. There was no evidence of involvement of the general peritoneal cavity.

#### SUMMARY

1. Perforation of small non-metallic foreign bodies, such as fish bones, chicken bones, or slivers of wood, occur most frequently in the large intestines, especially at the flexures and in the cæcum.

2. The condition is more frequent than is usually recognized. Of the twelve proven cases occurring at the Mount Sinai Hospital within the last ten years, nine were discovered in the last three years. The difficulties in recognition are due to the lack of any leading history, the failure to visualize this type of foreign body by the X-ray, and the wide variety in the clinical manifestations.

3. The condition may manifest itself in a variety of ways, of which the most common and important for the surgeon are:

1. Symptoms of acute peritonitis.
2. Localized intra-abdominal abscesses.
3. Intra-abdominal, usually peri-colonic, inflammatory tumors.
4. Tumor of the abdominal wall.
5. Abscess of the abdominal wall.
6. Inflammation and obstruction in a hernial sac.

4. In peri-colonic tumors, which do not invade the intestinal lumen, or cause stenosis, the possibility of the mass being a foreign body tumor should be considered. Recognition of this condition may decide the surgical indication, and avoid an unnecessary and hazardous surgical procedure, as removal of the foreign body and drainage, will suffice to effect a cure.

## NON-METALLIC PERFORATING INTESTINAL FOREIGN BODIES

The authors are indebted to Drs. A. A. Berg, Edwin Beer, C. A. Elsberg and A. V. Moschcowitz, for permission to publish the cases admitted to their respective services.

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- <sup>8</sup> Knud, Farber: Berliner Klinische Wochenschrift, vol. xxxv, p. 768, August 29, 1898. which had been removed at operation. The other was *in situ* but not perforating.

A STUDY OF THE VARIATIONS IN THE TENSILE STRENGTH  
OF SILK SUTURE MATERIAL

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A YEAR ago great daily variation in the tensile strength of the silk thread used for suture material in the Johns Hopkins Hospital was suspected. A study was undertaken to determine the exact extent of these variations, their causes, and methods of eliminating them, if possible. This study yielded some rather interesting facts regarding the thread used, especially the effect of various methods of sterilization upon its tensile strength. The method of study and the observations made are here given in brief form, together with the recommendations for the preparation of silk thread for suture material which were suggested as a result of the study.

*Method.*—The method of study was simple and objective. Its purpose was to determine, first, the normal tensile strength of the silk thread supplied for suture material in the clinic, and, in the second place, to observe the variations in the tensile strength under various experimental conditions. The method of testing the strength of a given bit of thread was as follows: It was cut into a length approximately eighteen inches long. This was then looped over the smoothly rounded hook of a sensitive spring scale, the two ends approximated and grasped with a gloved hand, and steady traction made on the thread until it broke. The reading on the scale at the moment the silk broke, expressed in pounds, was designated as its “pulling strength”. All the thread used was obtained from the same surgical supply house and was supposedly of the same grade and weight. Control tests of the thread and the scales were made before and after each group of experiments. A mechanical device on the scales permitted correction for the zero point before each test. There was no constant place at which the loop broke.

OBSERVATIONS

I. Thread taken from different spools varied greatly in tensile strength although the spools had identical markings.

Spool No. 1—Average “pulling strength”.....	7.0 lbs.
Spool No. 2—Average “pulling strength”.....	8.5 lbs.
Spool No. 3—Average “pulling strength”.....	9.0 lbs.
Spool No. 4—Average “pulling strength”.....	10.0 lbs.
Spool No. 5—Average “pulling strength”.....	10.5 lbs.

II. The thread on any given spool, however, was practically uniform throughout. Tests were made at intervals of ten yards over practically the entire length of a number of spools.

*For example:*

Spool No. 1—“Pulling strength”.....	7.0 lbs. on repeated testings
Spool No. 2—“Pulling strength”.....	8.5 lbs. on repeated testings
Spool No. 3—“Pulling strength”.....	9.0 lbs. on repeated testings
(And so with other spools.)	

## THE TENSILE STRENGTH OF SILK SUTURE MATERIAL

III. Immersing the silk thread in cold water for fifteen seconds caused an immediate loss in "pulling strength" of approximately 20 per cent.

*For example:*

Before wetting—"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.

Average .....	10.5 lbs.
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Immediately after wetting with cold water for 15 seconds—

"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.5 lbs.

Average .....	8.5 lbs.
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IV. Immersing the silk thread in boiling water reduced its pulling strength but slightly more than immersing it in cold water did.

*For example:*

(a) Before wetting—"Pulling strength"..... 10.5 lbs.

(b) After wetting in cold water—"Pulling strength"..... 8.5 lbs.

(c) After wetting with boiling water for 15 seconds—

"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.5 lbs.

Average .....	8.25 lbs.
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(d) After boiling in water for 1½ minutes—

"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.5 lbs.
"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.0 lbs.

Average .....	8.25 lbs.
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(e) After boiling for 5 minutes—

"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.0 lbs.
"Pulling strength".....	8.5 lbs.

Average .....	8.12 lbs.
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V. Silk thread which had been wet regained its original "pulling strength" if dried.

*For example:*

Before wetting—"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.
"Pulling strength".....	10.5 lbs.

Average .....	10.5 lbs.
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After wetting —	" Pulling strength ".....	8.5 lbs.
	" Pulling strength ".....	8.5 lbs.
	" Pulling strength ".....	8.5 lbs.
	" Pulling strength ".....	8.5 lbs.
Average .....		8.5 lbs.
After drying—	" Pulling strength ".....	8.5 lbs.
	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.0 lbs.
	" Pulling strength ".....	10.5 lbs.
Average .....		10.4 lbs.

VI. Sterilization in a steam autoclave did not cause a loss in the "pulling strength" of the silk thread, provided that all of the live steam was withdrawn from the sterilizer before the thread was removed. If this precaution was observed there developed no consolidation of moisture on the thread after its removal from the warm sterilizer.

*For example:*

Before sterilization—	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
Average .....		10.5 lbs.
After sterilization—	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
	" Pulling strength ".....	10.5 lbs.
Average .....		10.5 lbs.

VII. Immersing the silk thread in mineral oil did not cause a loss in "pulling strength."

*For example:*

Before moistening—	" Pulling strength ".....	10.50 lbs.
	" Pulling strength ".....	10.50 lbs.
	" Pulling strength ".....	10.50 lbs.
	" Pulling strength ".....	10.50 lbs.
Average .....		10.50 lbs.
After moistening—	" Pulling strength ".....	10.50 lbs.
	" Pulling strength ".....	11.00 lbs.
	" Pulling strength ".....	11.00 lbs.
	" Pulling strength ".....	10.50 lbs.
Average .....		10.75 lbs.

It is interesting that the oiled silk is apparently stronger even than the dry silk.

VIII. Heating silk thread in oil, even for a prolonged period of time, did not cause a loss in "pulling strength." (The oil in these experiments was heated to 110° C., that is, just below the boiling point for the oil.)

# THE TENSILE STRENGTH OF SILK SUTURE MATERIAL

*For example:*

Before wetting with oil—"Pulling strength"—Average, 10.5 lbs.  
 After wetting with oil at room temperature—"Pulling strength"—  
 Average, 10.50 lbs.

After wetting with oil at 110 degrees (C) for 1½ minutes—  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.

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Average ..... 10.5 lbs.

After heating in oil at 110° C. for 5 minutes—  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 11.0 lbs.  
 "Pulling strength"..... 11.0 lbs.

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Average ..... 10.75 lbs.

Here again it was noted that the silk was apparently stronger after being oiled than before.

IX. Oiled silk thread did not lose its "pulling strength" when immersed in water.

*For example:*

Before oiling— "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.

---

Average ..... 10.5 lbs.

After oiling and immersing in water—  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.  
 "Pulling strength"..... 10.5 lbs.

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Average ..... 10.5 lbs.

X. Waxing silk thread did not protect it quite so well from the effects of moisture as oiling did.

Before waxing—"Pulling strength"..... 10.50 lbs.  
 "Pulling strength"..... 10.50 lbs.  
 "Pulling strength"..... 10.50 lbs.  
 "Pulling strength"..... 10.50 lbs.

After waxing and immersing in water—  
 "Pulling strength"..... 9.5 lbs.  
 "Pulling strength"..... 9.5 lbs.  
 "Pulling strength"..... 9.5 lbs.  
 "Pulling strength"..... 9.5 lbs.

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Average ..... 9.5 lbs.

PRACTICAL CONSIDERATIONS

As a result of these studies, the following suggestions were offered for the sterilization and preparation of silk thread for suture material:

- (1) *First*, that only thread from tested spools be used.
- (2) *Second*, that the thread thus selected should be "dry sterilized" (in a steam autoclave) rather than by the older method of boiling in water.
- (3) *Third*, that the thread should be moistened with sterile mineral oil after it had reached the operating table, and before it was exposed to the moisture of the tissues of the operative field.

It was estimated that adherence to these suggestions would eliminate, to a great degree, daily variations in the tensile strength of the suture material, and would increase the average effective strength of the sutures placed from 50 to 100 per cent. For the past year these suggestions have been adopted as routine for the preparation of silk suture material on one of the major divisions of the surgical clinic. The results have been satisfactory, and have justified the procedures.

SUMMARY

1. Some facts regarding the variations in tensile strength of silk thread under various conditions have been reported.
2. The application of these facts to the preparation and sterilization of silk thread for suture material has been indicated.



# BRIEF COMMUNICATIONS

## CONGENITAL HERNIA OF UMBILICAL CORD

THE rarity of such a hernia, the clinical course and interesting anatomical findings, make the following case worthy of record.

In congenital umbilical hernia, the only structures making up the sac are the thin transparent Wharton's jelly and the parietal peritoneum. Failure of agglutination of the umbilical plates during fetal life, leaving a free opening in the peritoneal cavity leading into the umbilical cord, is responsible for the condition. It occurred in about one out of 5184 hernias, according to Lundfos. In the Ruptured and Crippled Hospital, in eighteen years they have had four cases in 75,000 hernias. In 92 laparotomies recorded up to date, 29 died, a mortality of 31 per cent.

*Treatment.*—If the hernia is of small size and easily reducible after replacing the contents, the cord may be ligated close to the skin junction and a pad applied over the umbilicus to be held in place by adhesive strips.

In large hernias, operation is advisable. Incise Wharton's jelly down to peritoneum, strip peritoneum away from Wharton's jelly down to ring and close peritoneum with fine catgut. Approximate the raw surface including all layers at the umbilical opening, with mattress sutures, and dress daily. In some cases, it may be necessary to incise the peritoneum in order to reduce the hernia and properly close it.

*CASE REPORT.*—Baby G., first child, normal pregnancy, normal delivery. The family physician, Dr. Frances Kardons, who delivered the case at the Borough Park Maternity Hospital (July 6, 1927) noticed as soon as the child was born, a hernia of the umbilical cord. Aware of the danger of injury to its contents, she clamped the cord about seven inches away from the umbilicus, and delivered the placenta.

The writer was then requested to see the case in consultation and he examined the child forty-five minutes following its birth. Findings: Male, normally developed, weighing 8 pounds, lusty cry. The umbilicus was about one inch in diameter. The umbilical cord was much wider, spreading out like a mushroom or an inflated finger cot. The sac was completely transparent and about the size of a tangerine orange. Through the Wharton's jelly and peritoneum, which constituted the sac, one could plainly see, as if through clear glass, the contents of the hernia. It consisted of three coils of small intestine, in all about eight inches long, and the appendix about four inches long, about the thickness of a goose quill. The blood-vessels of the mesentery of the intestine and appendix could be plainly seen pulsating. The intestine was constricted at the neck of the sac and appeared irreducible.

The baby was taken to the United Israel-Zion Hospital and was operated on about one and one-half hours following its birth. The skin and umbilical cord were considered practically sterile, therefore requiring very little further preparation. However, a weak solution of tincture of iodine was applied to the field of operation. An incision was made in the Wharton's jelly and peritoneum, extending for one-half inch upward into the upper portion of the skin and fascia of the umbilicus. The intestine together

with the appendix was then replaced into the peritoneal cavity. The umbilical cord was cut at its cutaneous junction. The umbilical vein and the two umbilical arteries were ligated. The abdominal opening was large enough to admit two fingers. It was closed by through-and-through mattress sutures of silkworm, interrupted, including all layers, the skin, fascia and peritoneum. The umbilical opening was closed in a transverse direction, thereby lessening the chances of separation. The appendix continually persisted in protruding from the abdomen until the last stitch was inserted. A continuous catgut suture was then used to approximate the peritoneum and the raw edges

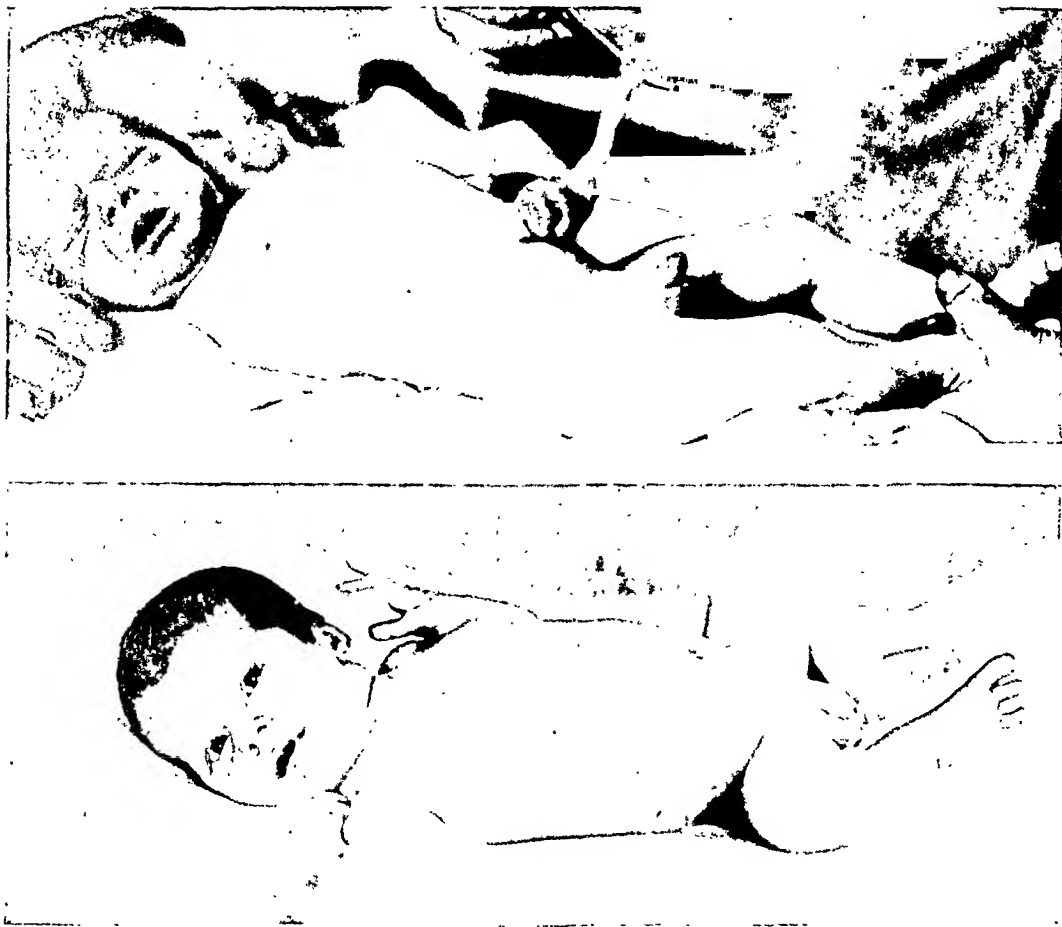


FIG. 1.—Congenital hernia of umbilical cord. Before and after operation.

of skin and fascia at the umbilicus. Dressing was applied, covered with two strips of adhesive and umbilical band. The operation lasted about eight minutes. No anæsthetic was used. The baby remained in good condition, apparently minding the procedure very little. The same day, shortly after operation, the child was taken back to its mother at the Maternity Hospital for its feedings. During her entire stay at the hospital, the mother was unaware of anything abnormal relative to her child.

*Post-operative Course.*—Bowels moved daily. Very little vomiting, no more than occurs with the average newborn. Temperature normal. Wound dressed daily, healing by primary union. Silkworm sutures removed on eighth day. Wound healed completely. At two weeks, the umbilicus has normal appearance, the infant appears healthy and is gaining weight.

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## THE MANAGEMENT OF WOLFE GRAFTS

### THE MANAGEMENT OF WOLFE GRAFTS

The use of the Wolfe graft is now an accepted part of the armamentarium of the plastic surgeon. Chief among the difficulties of technic encountered in their use is the suturing of this slippery graft on a slippery bed. Irregular and indifferent suturing is a common fault.

There are three necessary requirements for a successful "take": firm apposition, restoration of normal tension and accurate coaptation of the edges. It is with the latter requisite that the average surgeon discovers a stumbling block. Once dissected free, the graft is with difficulty sutured to

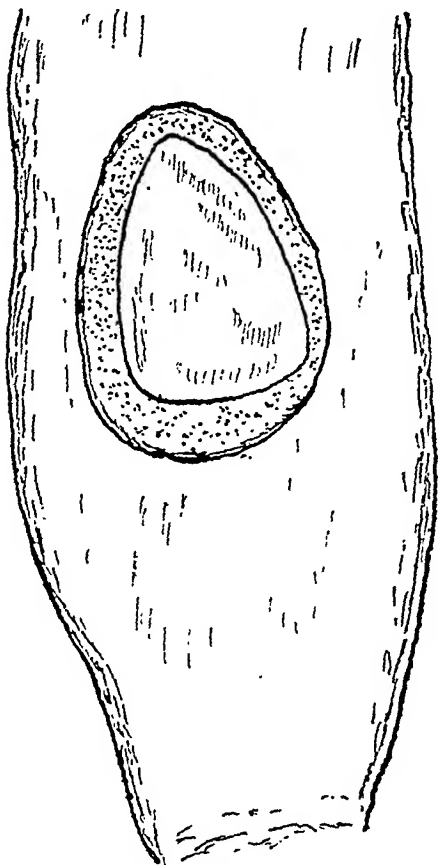


FIG. 1.—Graft cut from pattern to exact size of defect. Shrinkage may be noted.

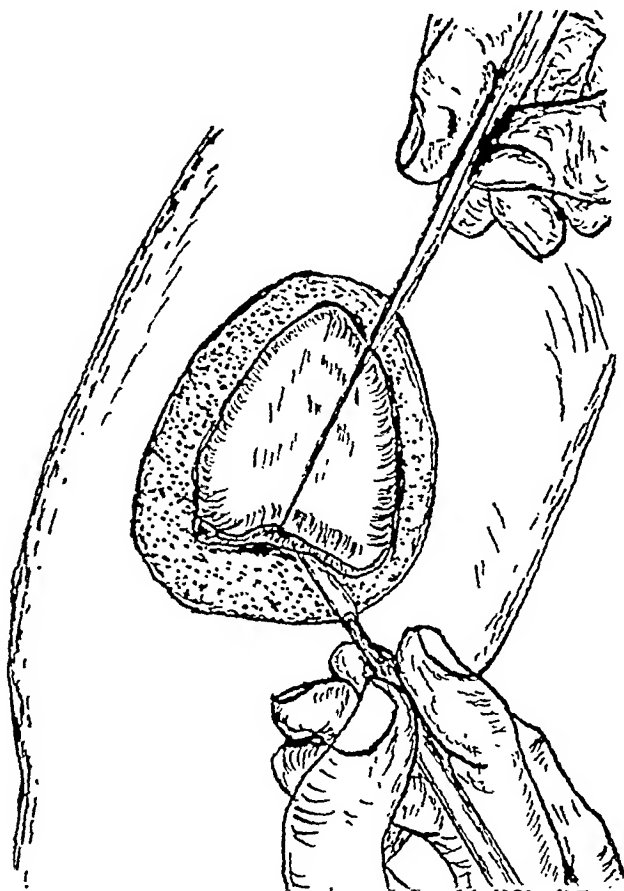


FIG. 2.—The edges of the graft are dissected free, leaving the base, or central portion still attached.

its new bed. Proper coaptation of the edges insures normal tension provided the graft is cut to the exact size of the defect and not one-sixth to one-half a size larger as most text-books advise.

During the cutting of these grafts, they curl and shrink to almost half the original size. The under surface becomes moist and slippery and the patience of even the most skilful surgeon is sorely tried before the graft is accurately sutured to the defect. This is especially true if the "non-touch" technic is employed. The following technic offers a solution to the difficulties encountered.

A pattern is cut to the exact size of the defect, using heavy tinfoil or thin sheet lead. The pattern is placed on the area selected and the graft outlined with the point of a knife. Small tissue hooks are now used to raise the edge of the graft and dissection along the edges is completed, leaving the

## BRIEF COMMUNICATIONS

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central portion still attached. Only a small amount of undercutting is used. When the edges are freed, sutures are placed through them, using horse hair on a fine sharp cutting needle. The fine tissue hooks are useful in straightening the curled edges while the sutures are being placed. As many sutures may be used as desired. If the final suture is to be a continuous one, place from six to eight of these fixation sutures in the graft. If interrupted sutures are to be used, they may all be placed at this time. The ends are left long and clamped together. If the needles are tied in they may be left, attached to the sutures, thus avoiding the necessity of

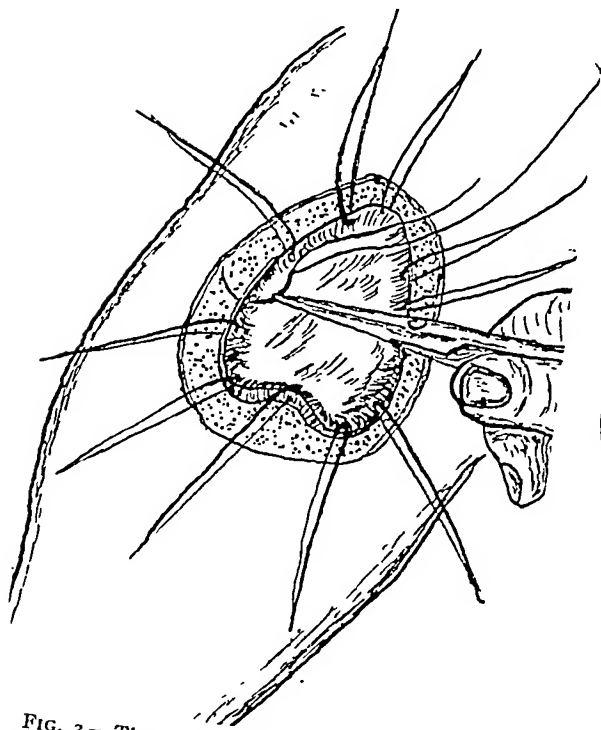


FIG. 3.—The sutures to be used in fixing the graft to its new bed are inserted through the edges. If needles are tied in, they may be left. The sutures are clamped together and used as a handle while completing the dissection.

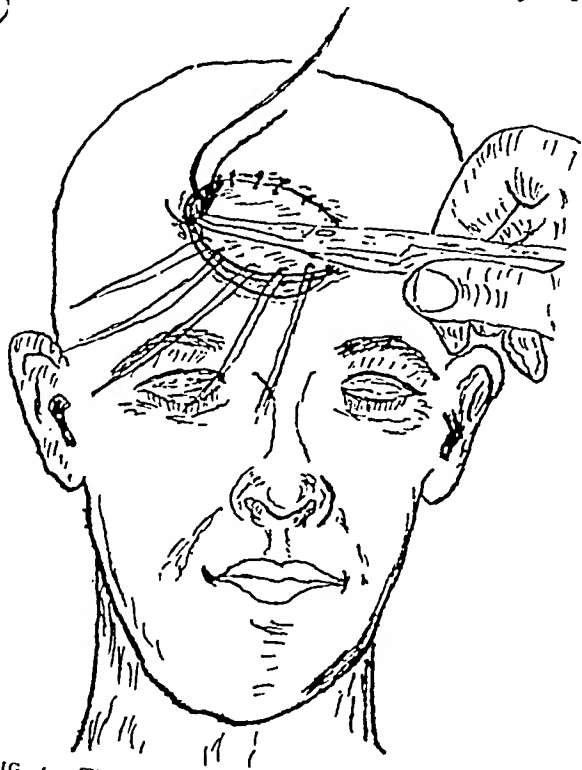


FIG. 4.—The graft is quickly and easily sutured to its new bed at normal skin tension, without danger of displacement or loss.

re-threading. Using the sutures as a handle, the dissection is continued until the graft is freed from its base and carried to the area to be covered. Here the graft is properly adjusted and, using the needles already in place, the sutures are carried through the skin margins of the defect. Here the sutures are

I. Minimal trauma to

1. Minimal trauma to the graft.
2. A firm base through which the sutures may be placed.
3. Accurate placement of sutures, insuring better coaptation.
4. Permits employment of the "non-touch" technic.
5. Eliminates danger of dropping the graft.

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# ACTINOMYCOSIS OF THE HARD PALATE

This case is reported on account of the unusual location of the disease. Arthur H. Sanford and Minna Voelker, who have collected and tabulated all reported cases in their article, "Actinomycosis in the United States," published in the *Archives of Surgery*, vol. xi, No. 6, have found no case in this situation. John Ruhrah in the *ANNALS OF SURGERY*, vol. xxx, p. 442, says: "The disease may occur as an ulceration of the mucous membrane lining the mouth. There have been two such cases in this country. In both the peculiar discharge led to a diagnosis. In one of the cases it extended through the cheek after having existed in rather a quiescent state." The detailed reports of both cases show that the lesions were situated on the mucous membrane of the cheek.

My patient, W. R. C., age forty-three, white, married, the proprietor of a country store, first came under observation December 1, 1926. His family history is negative except that one brother died with "miners' consumption". At sixteen years of age he had a gastric hemorrhage of unexplained origin. He has had no operation or other sickness. There is no history of venereal infection. For years he had made a practice of carrying a straw in his mouth.

About seven months previously he had injured the roof of his mouth with a splinter which he extracted himself. This bothered him for a few hours only. Four weeks before, a dentist who was extracting some of his teeth informed him he had some serious trouble with his palate. He had no subjective symptoms, however, and there was no history of cough or expectoration. There had been no recent loss of weight.

The patient was a spare active man whose physical examination was negative, except for the mouth, from which all the teeth had been recently extracted. The palate was high and sharply arched, and at the angle there was an elevated granulomatous, honeycombed swelling 1 x 2 cm. in size. Pressure caused the discharge of whitish-yellow pus from several points and slight bleeding. Neither probe nor X-ray showed any dead bone. The mouth was otherwise normal and there were no enlarged cervical glands. Dr. J. L. Lattimore reported the pus contained actinomyces and that the blood Wassermann was negative. Liberal doses of iodide of potassium and five radium treatments over a period of four months resulted in improvement but no cure. On May 2, 1927, under general anæsthetic an electric cautery was thoroughly applied to the affected area. This resulted in a prompt cure.

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## EPITHELIOMA OF THE CERVIX ASSOCIATED WITH CARCINOMATOUS CYSTADENOMA OF THE OVARY\*†

Major, in 1918, in an extensive review of multiple primary malignant tumors, studied 628 cases reported in the literature. He found that multiple primary malignant tumors do not have a predilection for organs of the same system, except paired organs, which is in marked contrast to their predilection for single organs. Major also observed that malignant new growths were more common in unrelated organs. The case of multiple malignant tumors

\* Submitted for publication, September 28, 1927.

† From the Section on Surgical Pathology of the Mayo Clinic.

of the pelvic organs which we are reporting is of a type which he rarely found, that is, multiple malignant neoplasms in organs of the same system. Major's data revealed that the uterus was the most common site of two tumors of different types, next in frequency the breast and thyroid gland. The most common combination of malignant neoplasms was carcinoma and sarcoma.

Owen, in 1921, studied multiple malignant tumors reported in the pre-



FIG. 1.—Carcinomatous papillary cystadenoma of the ovary.

vious ten years and found that in 3000 cases of carcinoma, approximately 4.7 per cent. were multiple. Basal-cell epithelioma was most frequently multiple, next in order basal cell and squamous-cell carcinoma, then multiple squamous-cell carcinoma, multiple carcinoma of the breast and then carcinoma of the breast with some other type of carcinoma. In these reports or in other cases in the literature,<sup>3, 4, 5</sup> we were unable to find a case similar to the one presented here.

CASE.—A woman, aged fifty-seven years, the mother of four living children, came

to the Mayo Clinic because of a mass in the lower part of the abdomen, which had been noticed about three months previously. The family and personal history were unimportant. The climacteric had been passed nine years previously. About five months before examination she noticed urinary frequency, urgency and nocturia accompanied by suprapubic pain which was severe during micturition. These symptoms persisted for two or three weeks and then disappeared. A mass was noticed about six weeks later. An occasional foul purulent vaginal discharge without bleeding followed the first symptoms. Later about 5 c.c. of stringy blood came from the vagina on one occasion after voiding. At the time of admission there were no urinary complaints. The appetite was good and the bowels were regular. There was no appreciable loss of weight.

Physical examination was negative except for a slightly tender, rounded abdominal tumor which extended nearly to the umbilicus. On vaginal examination the entire pelvis was filled with a lobulated but not definitely tender mass. The fundus could not be made out. There was some bleeding following examination. Exploration of the abdomen was advised.

## EPITHELIOMA OF THE CERVIX

When the cervix was cut across mucoïd material escaped from the uterus. After malignancy was determined the cervix was completely removed. There was a cyst in the left ovary about 14 cm. in diameter which contained mucopurulent material. The pelvis was carefully washed with large quantities of water and drainage instituted. On the second day after operation pulmonary complications developed which resulted in death five days later.

At necropsy bronchopneumonia and pulmonary œdema, and fatty changes in the



FIG. 2.—Carcinomatous cystadenoma of the ovary. (x 60.)

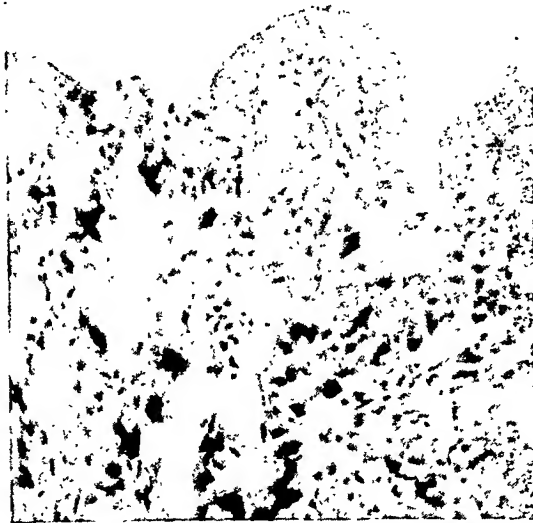


FIG. 3.—Metastasis of the ovarian tumor to the uterus with polymorphonuclear leucocytes in the spaces of the tumor. (x 120.)

liver associated with chronic diffuse nephritis, were noted. Careful search failed to reveal evidence of metastasis from the carcinomas removed at operation.

The specimen removed at operation weighed 580 gm. The left ovary contained



FIG. 4.—Metastasis of the carcinomatous cystadenoma of the ovary to the cervix. (x 60.)

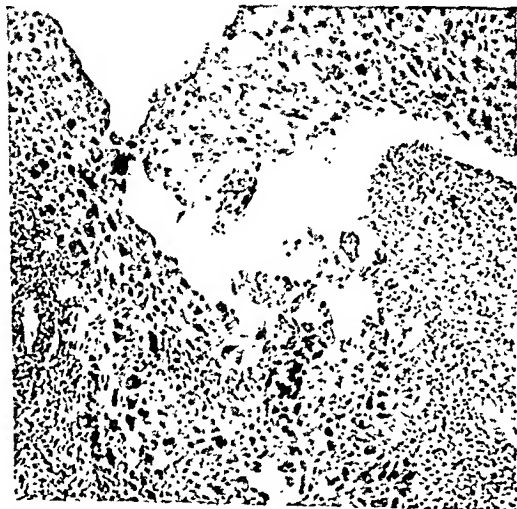


FIG. 5.—Squamous-cell epithelioma of the cervix graded 4. (x 60.)

a malignant papillary cystadenoma, approximately 8 by 8 by 12 cm., which involved the whole inside of the ovary (Fig. 1). The right ovary was small and atrophic. The uterus contained a quantity of purulent material and mucus.

The tumor of the ovary was composed of fibrous connective-tissue stroma covered by a layer of epithelium of varying thickness (Fig. 2). The cells of this epithelial covering were large with one or more nucleoli, characteristic of malignant cells. The stroma of some of the papillæ was myxomatous. In the spaces of this ovarian tumor

were polymorphonuclear leucocytes. On the surface of some of the sections was a mucoid-like substance.

The lining of the uterus was composed of a varying number of layers of epithelial cells with the large nucleus and nucleolus of malignant cells.<sup>5</sup> In general they were much like the cells described in the ovarian tumor. Interspersed among these malignant cells were a great many polymorphonuclear leucocytes, which supported the gross diagnosis of pyometrium (Fig. 3).

In the cervix similar malignant cells were present (Fig. 4). There were also areas of large hyperchromatic squamous cells invading the substance of the cervix. A few of these cells contained a little keratin, but most of them were undifferentiated. This squamous-cell epithelioma was graded 4, according to Broder's classification (Fig. 5).

COMMENT.—When two related tumors are found in the same organ, the question always arises: Is this an example of metaplasia, or are there two distinct primary tumors? In this case we feel reasonably certain that the two neoplasms were not the result of metaplastic activity of the cells of the carcinomatous cystadenoma, for the epithelioma in these sections could be traced directly from the basal layer of the cervical epithelium. In no place in the sections were the two tumors changing from one type to another.

Similar multiple malignant tumors in the same organ may be caused by carcinoma arising from several centres simultaneously, and later these may coalesce. Multiple tumors of the same kind may be a coincidence or the result of metaplasia.

Careful routine examination of operative specimens in many instances will reveal multiple malignant processes.

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#### THE TECHNIC OF RECTAL ANÆSTHESIA IN GOITRE SURGERY\*

For the past two and one-half years, Gwathmey's rectal anæsthesia has been used in preference to other types of anæsthesia in practically all the goitre cases operated on by me at the New York Post-Graduate

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\* From the Goitre Clinic of Dr. Charles Gordon Heyd at the New York Post-Graduate Medical School and Hospital.



Hospital. This series is rather small, numbering thirty-four at the present time, but the results have been so uniformly satisfactory that rectal anæsthesia would seem to have a very important place in thyroid surgery.

*Technic.*—Time of operation: two P.M.

*Pre-operative Treatment.*—At eight P.M. the night before operation, the patient receives pulv. glycerrhizæ drams two to three. At seven A.M. the morning of operation, a soap suds enema is given. This is followed immediately by a colonic irrigation of warm water. This irrigation is to be administered until the return is absolutely clear, from six to ten gallons of water being used. This should be completed not later than nine A.M. At nine-fifteen A.M., morphine sulphate grains one-eighth, one-sixth, or one-fourth is given, the amount of the dose depending on the body-weight of the patient. The patient is to remain in bed from that hour on. At twelve noon, chloretone grains fifteen, ether drams two, and olive oil drams four is administered through a rectal tube which has been inserted eight to ten inches above the anus. The tube is clamped but allowed to remain in the recto-colon. The patient is placed in a left Sims' position and allowed to sleep. At twelve-fifty P.M., a second dose of morphine grains one-eighth, one-sixth, or one-fourth is given, plus atropin grains one-one hundred and fiftieth. This dosage is governed by the patient's reaction to the previous medications. The nurse is in charge of all treatment up to this point.

*Administration of Anæsthesia.*—At one P.M. a mixture of olive oil ounces two, ether ounces six, and paraldehyde drams one, is introduced through the rectal tube which has remained in from the previous medication. The patient should receive one ounce of this mixture per twenty pounds of body-weight, at the rate of one ounce every five minutes, or a total of forty minutes for the introduction of an eight ounce mixture. The tube should be on a level with the patient for the expulsion of gas. If the patient complains of cramps, or the desire to evacuate bowels, it will be necessary to stop the flow of the solution and lower the tube for the escape of flatus. When the required amount of mixture has been given, the tube is clamped and allowed to remain in the rectum throughout the operation. If the patient has not been narcotized by the time the mixture has been introduced into the rectum, the anæsthetist may allow her to re-breathe through a Bennett inhaler. This prevents the loss of the anæsthetic through the expired air. One must be careful that the mask does not touch the patient's face while conscious. If it ever becomes necessary, a small amount of ether may be added to the Bennett inhaler until the operation is started. We have never had to keep the patient anæsthetized longer than forty minutes by this method, but Miss Smith has kept one patient under in this way for one hour and forty-five minutes. As soon as the operation has been completed, the tube which has remained in the rectum is unclamped and any remaining mixture is drained off.

*Post-operative Treatment.*—The patient is returned to her room and a cold colonic irrigation of from four to six gallons is given at once. This is

followed by a retention enema of olive oil, two, four, or six ounces. It is best not to use a Murphy drip with a patient who has had rectal anæsthesia. A hypodermoclysis of one thousand c.c. of saline is administered immediately after completing the colonic irrigation, which is absorbed before regaining consciousness. The patient may receive morphine grains one-eighth, one-sixth, or one-fourth, when necessary. In cases of hyperthyroidism of the Graves' type, Lugol's solution drams one-half is given, as soon as the patient can swallow. If the patient is critically ill, Lugol's solution drams two or three may be used in a retention enema on completion of the colonic irrigation.

This series of cases includes five substernal goitres, seven adenomas without hyperthyroidism, and five adenomas with hyperthyroidism. The highest metabolic rate was plus fifty-four and the lowest plus eleven, the average being plus thirty-one and one-half. There were seventeen cases of exophthalmic goitre or Graves' disease, of which the highest metabolic rate was plus ninety-six and the lowest plus twelve, with an average of plus forty-eight and one-tenth. In this series of cases, there have been no complications such as pneumonia, bronchitis, or gastro-intestinal disturbance, resulting from the rectal anæsthesia.

CONCLUSIONS.—1. The cases of exophthalmic goitre make an exceedingly smooth post-operative recovery. 2. The substernal goitres are delivered with much less bleeding than by either nitrous oxide, or ethylene anæsthesia.

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## BOOK REVIEWS

SURGICAL DISEASES OF THE GALL-BLADDER, LIVER, AND PANCREAS, AND THEIR TREATMENT. By MOSES BEHREND, M.D., 8vo, cloth, pp. 250. Philadelphia, F. A. Davis & Co., 1927.

The author presents as a monograph an elaboration of numerous contributions on gall-bladder surgery which have appeared in current medical journals.

Perusal of this volume conveys to one familiar with surgical literature that it mirrors the teachings of Deaver; furthermore, it is preëminently clinical in its exposition; to witness the exclusion of laboratory methods as aids to diagnosis. We welcome finding its pages unencumbered with the history of past performances, since the personally tried and tested everywhere prevails, and it is only by the mention of a name appearing in the text and accounted for in an adequately appended bibliography, that a connecting link with the historical past is established.

The chapters on Anatomy, Pathology, and Physiology are collaborated by authorities in their respective fields in the first five chapters embracing nearly half of the book, thus constituting an essential foundation for the didactic presentation of the subject matter, complementary to which are abundant illustrations.

Chapter III on the Anatomy of the Ducts and Blood-vessels must be regarded as an outstanding feature of this book. The story thereof is succinctly told in five pages, the remaining forty-five by virtue of the excellent full page drawings very graphically reveal the anomalies. It is worthy of note that such appeared in advance of the surgical narrative. As a rule the anomalous is treated anomalously and mentioned *en passant* or at the end; but here it occupies a foremost place and rightly so when one reads that there are 25 per cent. of duct variations and 50 per cent. of vascular departures from the normal.

The author logically aligns his attack on the gall-bladder by what he designates the "open method" as opposed to the "blind method". This implies singling out the biliary and vascular pedicle through an incision in the right free border of the gastro-hepatic omentum. To quote "this is the logical method when comparison is made with other organs requiring removal."

Infection as the ultimate cause of gall-bladder disease is so nearly universally conceded that it is not material for issue, but whatsoever we know of the infectious origin of stones should have been supported by a brief reference to the classical work of Bacmeister and Aschoff. Our under-

standing of the mechanism of infection is not furthered by subdivision into primary comprising the organs, duodenum, appendix inclusive of the blood and secondary emanating from systemic diseases dispersing infection through the blood, in as much as the primary grouping may also be of hæmatogenous origin. That the bacterial examination of the bile as cultured at operation is usually sterile, exceptionally infectious, meets with apparent contradiction, that aspiration of the gall-bladder be not resorted to in collapsing the same lest escaping contents contaminate and fatal issue result.

Partiality toward nitrous oxid and oxygen in spite of admitted inadequate relaxation, to be overcome by manual dexterity, is buttressed by the needs for the same because of the frequent incidence of high blood-urea-nitrogen, and the increased liability of pneumonia where ether is used. Be that as it may, it should not have precluded the mention of novocain anæsthesia, regional, spinal or para-vertebral in the extremely sick gall-bladder patient for the performance of external drainage or internal drainage to be superseded by nitrous oxid and oxygen where more protracted work is called for.

That the gall-bladder may be the nidus of focal infection responsible for co-existing myocarditis is aptly stressed but conversely this fact should have been embodied in the chapter on differential diagnosis that epigastric distress concomitant of myocarditis should direct attention to the gall-bladder as the *fons et origo*, calling for surgical relief.

Radiography and cholecystography receive their proper evaluation in being limited to cases which not being clear-cut do not reveal themselves. The Lyons drainage is but faintly praised for its diagnostic value and not much more from a therapeutic standpoint. The Charcot syndrome is referred to as a diagnostic aid without precisising the symptoms that characterize it. In this connection the omission of the law of Courvoisier for differentiating between carcinoma and stone should be noted since it has found a place in all dialectics on this subject.

In chronic jaundice with cholemia due to common duct obstruction other than stone, after adequate preliminary preparation, hepatico-duodenostomy is offered as the operation of choice save for the complicating pancreatitis where cholecystostomy is regarded as the operation specially indicated. Otherwise the author would relegate cholecystostomy to oblivion for he is an out-and-out exponent of ectomy. In few words, in no way departing from the usual limited interference for its relief, acute hemorrhagic pancreatitis is dismissed. Likewise cysts of the pancreas.

The final chapter is a thesis in experimental surgery "On Ligation of the Hepatic Artery," the outcome of which is dangerous at all times, thus substantiating its futility when applied to the human in few instances for aneurism or wound of the artery, because of the large areas of liver necrosis that ensue.

MARTIN W. WARE.

## BOOK REVIEWS

1. SCIENCE AND PRACTICE OF SURGERY, by W. H. C. ROMANIS, F.R.C.S., Teacher of Practical Surgery, St. Thomas' Hospital, and PHILIP H. MITCHINER, F.R.C.S., Teacher of Operative Surgery, St. Thomas' Hospital. Large octavo; cloth; 2 vols.; pp. 795 and 955; New York, Wm. Wood and Co., 1927.

2. SURGERY, ITS PRINCIPLES AND PRACTICE FOR STUDENTS AND PRACTITIONERS, by ASTLEY PASTON COOPER ASHHURST, M.D., Professor of Clinical Surgery, University of Pennsylvania, 3rd edition, revised; large octavo; cloth; pp. 1179; Lea and Febiger, Philadelphia, 1927.

3. MANUAL OF SURGERY FOR STUDENTS AND PRACTITIONERS, by ALBERT CARLESS, F.R.C.S., Consulting Surgeon, King's College Hospital, and CECIL P. G. WAKELEY, F.R.C.S., Assistant Surgeon, King's College Hospital. Twelfth edition; large octavo; cloth; pp. 1544; New York, Wm. Wood and Co., 1927.

Of the surgical text-books appearing in the Fall of 1927, the book of *Romanis and Mitchiner* is an entirely new candidate for surgical approval. A notable feature of the London hospitals and medical schools is the appearance, from time to time, of text-books and manuals which, in a special degree, represent the standards of individual hospitals. So here we have the St. Thomas Hospital surgery; its authors, two of the younger members of the surgical staff and the book itself dedicated to the consulting surgeon at the same hospital, Sir George Makins, whom the authors characterize with affection as their friend and teacher.

A point which strikes the reader who consults this book is the fact that it is in two volumes, neither one of which is too large for comfort in handling. This is really a great convenience to appreciate which one has simply to consult one of the larger one-volume text-books of fifteen hundred and more pages and compare it with these volumes under review. We note with interest the reference by the authors to the multitude of chemical tests and laboratory examinations which are now employed in connection with surgical cases. They deplore that such methods should be used to establish a diagnosis so often with complete neglect and disregard of clinical aspects and personal subjective symptoms of patients. To this observation the reviewer wishes to add his full sympathetic assent. Not that he would have the laboratory work slighted at all, but that it should be used more than it is to confirm or correct the careful clinical diagnosis. One sees a special object in this book as a text-book for students in preparing for the various surgical examinations to which they may aspire in England in the arrangement that to many of the chapters a preface is furnished giving an account of the applied surgical anatomy or physiology of the organ discussed. It goes without saying that the book being a presentation of the surgery of one of the great London hospitals, is of interest and value.

One little point has attracted the attention of the reviewer which has gained undue importance possibly in the editorial mind in his own work in

frequent reviews of the American surgical literature of fractures, namely, the dreadful misuse by American surgeons of the word "cast" in referring to the use of plaster-of-Paris in the fixation of fractures. As all men know, if they give the matter a thought, a "cast" is something poured into a mould in liquid form and there solidifying so as to take a desired shape. The plaster bandage applied about a fractured limb forms a mould of the limb, a case enveloping the limb and not a cast. How the transposition of terms originated, I do not know, but its almost universal use among American surgeons, and from them among the laity, is a deplorable fact. The frequency with which, in order to keep the pages of the *ANNALS OF SURGERY* free from the presence of this literary crime, the editor has to delete the word "cast" from the manuscripts submitted to him and substitute the word "case" would be amusing to the onlooker though extremely exasperating to the editor. It was with great satisfaction, therefore, that in looking over the paragraphs devoted to fixation of fractures in the book under review, he found that the term "plaster cast" did not appear, although full description of the use of plaster-of-Paris for the fixation of fractures is given and the result of its use is spoken of as a "casing" and not a "cast". While on this subject, I am stimulated to propose the organization of a society to abolish the use from American surgery, of the word "cast" in the description of plaster bone splintage or joint fixation.

Comparable with the book of Romanis and Mitchiner is the volume by *Ashhurst*. This is a one-volume book containing 1179 pages, profusely illustrated, a volume still quite convenient for handling. Every page of this book shows the evidences of a practical surgeon and a scholarly mind, a worthy successor to the book of the elder Ashhurst who, if he is now permitted to look over the battlements of a surgical Valhalla, must recall with delight the contests of his own earthly pilgrimage and approve the work of his successor. The book is an excellent presentation of the best class of American surgery and has the special merit of having gone through the process of distillation through the alembic of a single critical mind. As one takes it up, there come back memories of other similar publications in the past such as those of Gross, John Ashhurst, Senn, Wyeth, Fowler and others, each of which in their day and generation, brought credit to American surgery. Although this book bears the description of a third edition, it has nevertheless been so revised, that it is practically a new book. Like its London compeer, it represents the work of a particular hospital, the Episcopal Hospital of Philadelphia. If Doctor Ashhurst should be tempted to read this review, we hope that he will make a practical application in future editions of the criticism above of the use of the term "cast" in describing a gypsum case when he comes to revise page 131.

*The Manual of Surgery*, by *Carless and Wakeley*, presents itself as the 12th edition, evidently continuing the life of the *Manual of Surgery*, first

issued by Rose and Carless in 1898. That a manual first issued thirty years ago should be the subject of sufficient demand to call for a new edition to-day, would signify not only great merit in the original treatise, but also a constant watchfulness in the successive editions to keep it up to the demands of the kaleidoscopic changes which the surgery of these years has presented. It is evident that the junior author of the first edition, who is now the senior author of the twelfth edition, is the important factor which has maintained the manual at a constant high mark during all this period. Mr. Carless is to be congratulated at having enjoyed so prolonged a surgical life as to see his book reach a twelfth edition. He is now an emeritus professor and consulting surgeon of his hospital and feels called upon, in this last edition of his book, to express his indebtedness to the collaboration of his old house surgeon, Mr. Cecil Wakeley, in bringing out this new edition. The Manual, on its title page, bears the names no longer of Rose and Carless, but of Carless and Wakeley as its authors. The book represents the surgery of King's College Hospital, London. It is dedicated to Lord Lister the last years of whose active work were spent at King's College Hospital. In the preface a most delightful tribute to the character and influence of Lord Lister is given. In this tribute, after describing the uniform success of the antiseptic treatment as carried on by Lister, Mr. Carless goes on to speak of another phase of Mr. Lister's influence, to the truth of which the reviewer can testify from his own personal observation. I cannot resist the temptation of copying it here.

"In still one other direction has Lister's influence made itself felt, viz., in the transformation of the surgeon himself. Only too frequently in the past did the terrifying results of operative work appear to brutalize the operator, and, indeed, how could it be avoided when the outcome of his work was even more dreadful than the result of the disease or injury he was endeavoring to cure? Lister introduced a new regime, in which hope grew and confidence flourished; this has reacted on the surgeon himself, and produced a new type, in which gentleness and carefulness have replaced reckless rapidity. Lister himself, as an operator, was deliberate and cautious; rarely did he do anything theatrically showy, although I have seen him remove two stones from a bladder by lateral lithotomy in fifty seconds; but this was an unusual episode, and the applause which followed was to him most distasteful. He, more than any other, may be looked on as the ideal surgeon, both in character and work—humble, and with no eye to his own advantage, and yet "valiant for the truth"; courteous to all; and ready to take every trouble and to sacrifice himself in every way to help his patients, thinking first of them and of their welfare. One's personal observation of him made one realize that he considered himself a man with a mission—viz., to demonstrate to the world that the rapid and uneventful healing of a wound was an inherent possibility in all human beings, if only Nature were not interfered with by inimical external influences."

The Manual of Carless and Wakeley is a good book notwithstanding the unwieldy bulk of its more than fifteen hundred pages within a single cover. The book continues to present well the English surgery of to-day.

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## BOOK REVIEWS

A TREATISE ON ORTHOPEDIC SURGERY, by ROYAL WHITMAN, M.D., M.R.C.S. Eighth edition, thoroughly revised. Large octavo; cloth; pages 1061. Philadelphia, Lea and Febiger, 1927.

The first edition of Whitman's treatise appeared in 1901. That the work has proved to be valuable and acceptable to Orthopedic surgeons and to all interested in the maintenance of bodily symmetry is shown by the frequent editions which have steadily appeared since that time. When Robert Osgood was reviewing the sixth edition in January, 1921, he declared the book to be the best American text-book on the subject. This opinion was based upon the clear and readable style of the author, the simple but yet sufficiently detailed pathological descriptions which it presented and the helpful elements of differential diagnosis which it contained, all leading up to descriptions of methods of treatment the excellent end results of which are the best criteria of their value. The first edition of the book was dedicated to Virgil P. Gibney, his chief in the work of the New York Hospital for Ruptured and Crippled, with the work of which institution Doctor Whitman was associated. With the advance of years, Doctor Gibney has withdrawn from active work and Doctor Whitman himself is the Surgeon-in-Chief of the hospital in which they labored together for many years. The increasing experience from such opportunities are embodied in this last and revised edition of the book. The author, in his preface, declares that a comparison of the present edition with the first demonstrates the great advance both in scope and method of orthopedic surgery during the last twenty-five years. The reviewer agrees in the claim that the book has gained in interest and authority with each succeeding issue.

LEWIS S. PILCHER.

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